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Volume III OCTOBER, 1933 Number 4

PSYCHOLOGY OF LEARNING, GENERAL METHODS OF TEACHING, AND SUPERVISION

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Psychology of Learning, General Methods of Teaching, and Supervision

(Literature reviewed to January 1, 1933)

Prepared by the Committee on Psychology of Learning, General Methods of Teaching, and Supervision: W. A. Brownell, H. G. Wheat (resigned January 18, 1933), and G. T. Buswell, *Chairman;* with the assistance of Howard Easley, M. C. Towner, and D. R. Dodd.

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FOREWORD

THE authors of the present number of the *Review* have called attention, in their introduction, to the difficulty of distinguishing studies of supervision from studies of other problems. The same difficulty obtains, to a lesser extent, in connection with the studies of the psychology of learning and of general methods. This difficulty in distinguishing sharply the various fields leads to some overlapping in the literature which is reviewed in the treatment of the several topics. However, this evil of overlapping should not be magnified. A comparison of the bibliographies of related topics will show that the number of references which occur in two or more numbers is a comparatively small fraction of the total. It may be possible to reduce still further the overlapping if the Association can establish a central bibliographical office which will collect all the references to be reviewed and distribute them to the various committees. It is to be hoped that such a service will one day be established. In the meantime, it should be pointed out that it is sometimes desirable to refer to the same study in more than one *Review*, since it may bear on more than one problem.

Some of the readers of the *Review* have expressed the desire that the summaries should be somewhat more critical than most of them have been. The present number is an adventure in this direction. In the opinion of the writer the more critical treatment will be found helpful.

FRANK N. FREEMAN,
Chairman of the Editorial Board.

INTRODUCTION

THE committee experienced considerable difficulty in finding a satisfactory scheme for classifying the materials. The original assignment of the editorial board was limited to the topic "The Psychology of Learning and General Methods." After the committee had been appointed the topic of "Supervision" was added. The plan finally adopted was to present the material in three chapters, one dealing with the types, characteristics, and problems of learning, a second chapter dealing with studies pertaining directly to the teaching process, and a third chapter dealing with the general conditions affecting teaching and learning. It is obvious that there is a considerable amount of overlapping in these chapters. In the very nature of the case there must be overlapping in learning, methods, and supervision. In many cases references had to be classified in a purely arbitrary manner and in a considerable number of cases the same reference is considered in more than one place. The committee experienced particular difficulty in dealing with the subject of supervision. In view of the original assignment, namely, learning and methods of teaching, the committee inferred that any type of administrative supervision would not be pertinent to this particular *Review*. However, the topic, "supervision of instruction," seems to be somewhat too limited to satisfy many members of the profession who think of supervision as their particular field. The dilemma of the committee was rather well expressed in a portion of a letter from Dr. Wheat which is reproduced below:

> I have almost arrived at the conclusion that there is no such thing as a distinct technic of supervision that is separable from those of instruction and administration. I can conceive of two fields of administration; business and educational; and I should be willing to call the latter supervision, but discussions of supervision appear to carry the implication that this would be in error. I am aware of so-called supervisory technics and of alleged researches in such technics, but I cannot distinguish them from experiments in learning and in the management of learning activities, which we call instruction, or, perhaps, general methods. . . . The work of the teacher is in reality the work of supervision. The teacher is really the supervisor of learning activities. What does the supervisor do in the employment of his technics? To my mind, nothing more than guide or assist or make easier the teacher's activities of supervision. How, then, can we possibly have a research in supervision which is not primarily a research in learning? To my mind, the thing is hardly possible; and, when attempted, the real issue, that of learning, is clouded and the end of research is defeated from the beginning. On the other hand, all researches in learning have involved management, direction, supervision; but we do not call them by the latter names.

The committee finally took the position that learning, methods, and supervision, are to such an extent an integral part of the educative process that they cannot be treated adequately under separate classifications. Furthermore, the committee did not feel convinced that there is yet any distinct technic of research to be classified as a supervisory technic which is different in essence from the type of research carried on in studying problems of

learning or method. The committee considers that some of the most basic and fundamental material for supervisors will be found reviewed in Chapters I and II, which deal with learning and teaching. In Chapter III appear certain topics which in popular thinking are probably more closely related to the general subject of supervision. Perhaps to the extent that the committee's classifications are unsatisfactory discussion will be stimulated tending toward a more suitable terminology relating to these aspects of education.

One further word of explanation is needed with respect to the method which is employed in reporting the results of the investigations under review. It should be understood that the committee does not in any sense guarantee the validity of conclusions except in the case of such studies as are the object of explicit criticism.

G. T. BUSWELL, *Chairman,*
Committee on Psychology of Learning, General Methods of Teaching, and Supervision.

CHAPTER I

Types, Characteristics, and Problems of Learning

GENERAL ABILITY (INTELLIGENCE) AND LEARNING

Intelligence Level as a Condition to Learning

Considerable interest has been manifested in determining the degree of maturity or the intelligence level necessary to successful learning. Knight and Manuel (156) reported data on a group of sixty-two high-school graduates who entered the first grade at age six and on another group of forty-one who entered at age seven. In terms of amount of time spent in school, average of high-school marks, and the like, the advantage seemed to lie slightly with the six-year-old group.

Three studies have been made in connection with high-school learning. In Maller's study (181), based upon the records of 5783 high-school graduates, age at entrance into the high school seemed to be as good a predictive index of success as was I. Q. (intelligence quotient). Age at entrance correlated with average of marks to the extent of —.40, as compared with a correlation of .36 between I. Q. and marks. Kaulfers (146), while recognizing the fact of many individual exceptions, suggested that an I. Q. of 105 is required for success in high-school Spanish as now organized. In the case of algebra, Jackson (135) located the critical point at 110; such a student "can learn if he wants to." Of those with I. Q.'s below 110, 40 percent fail; of those with I. Q.'s above 110, 34 percent fail.

Gillet (96) and C. W. Washburne and others (267, 268) reported parts of the same large investigation which sought to determine the grade placement of topics in arithmetic in terms of mental age. Recently pointed attacks have been levelled against the technics employed as, for example, in the article by Raths (220). MacLatchy (178) presented detailed data concerning the number abilities of children upon entering school, these abilities being closely associated with level of intelligence. First-grade reading-readiness as related to intelligence has been the object of three investigations. The factors making for reading-readiness were analyzed by Deputy (71), who then used for his measurements scores on an intelligence test and on several tests of special functions. Scores on the intelligence test correlated higher with his criterion of success than did the scores on the special tests, thus indicating the importance of mental maturity as a condition to success in reading. Morphett and C. W. Washburne (193) in 1928 investigated the relation of success in reading with 141 first-grade children and found M. A. (mental age) to correlate .50 to .65 with scores on the tests used. The minimal mental age for reading instruction was set at six years and a half. Results of a similar study the following year confirmed these findings.

Intelligence and Learning of the Laboratory Type

In learning of the laboratory type children of varying degrees of general ability have been found, in general, to differ. Cuff (67) presented data to show that the brightest fifth of seventy-five college students profited less from the repeated reading of nonsense material than did the dullest fifth. Pyle and Snadden (217) presented learning curves for twelve very bright and for eight less bright high-school pupils in nine kinds of ideational and three kinds of motor learning. While, as usual, the brighter children excelled, in some of the types of learning a few of the duller children equalled and even surpassed the brighter ones. F. T. Wilson (277, 278, 279, 280, 281) made a number of comparisons of the learning of bright and of dull children in such tasks as that of learning the Goddard formboard, of memorizing Gregg shorthand symbols and unusual multiplication combinations, of recalling the ideas in a selection read to them, and in playing a game, success in which lay in perceiving a certain relationship. From his data he concluded that bright and dull children (ages nine and twelve) learn in essentially the same way. They have the same points of ease and of difficulty and they differ largely, if not chiefly, in the number of their mistakes. These conclusions, insofar as they run counter to the usual findings, may owe their difference to (1) the small number of his subjects, (2) the types of learning studied, and (3) the crudeness of the measures.

Intelligence and Learning of the School Subjects

College Level—Grant (100) found positive relation between intelligence test data and certain learning tests. That intelligence test scores are not to be taken as completely satisfactory indexes of comparative achievement in the college was shown by Dilley (74) and Nield (197) in two studies of students whose scores were low. While in general these students earned poor marks there were many exceptions.

Secondary Level—Three studies emphasize the positive relationship between intelligence and achievement in the high-school subjects. Waples and C. A. Stone (266) discovered a high degree of correlation between the I. Q.'s of the eight junior high-school pupils for whom they reported detailed data and the rate at which they learned to apply an algebraic principle to practical situations. This coefficient (.915) was compared with that of .333 between I. Q.'s and scores on the unit test as a whole. MacRae and Uhl (180) showed that brightness is associated both with general success in learning algebra and with the absence of certain described types of errors. Kaulfers (147) found correlations ranging from .43 to .53 between the I. Q.'s of high-school students and their marks in from one to six semesters of Spanish. Several studies stress the importance of other factors than intelligence. Maller (181) pointed out the importance of age, apart from I. Q., as a determiner of success in high-school work. Intelligence measures were reported by Stokes (242) to correlate less highly

with achievement in ninth-grade mathematics than measures of "sustained application." Background in Spanish was shown by Kaulfers (144, 145) to become an increasingly important factor, and I. Q. an increasingly unimportant factor, in later courses in Spanish. The same author (148) summarized a total of 612 coefficients of correlation between achievement in foreign language and other factors; the correlations with many of these factors are higher than those with intelligence.

Elementary Level.—By far the greatest number of investigations have been made in connection with the elementary-school subjects. In general a close correspondence has been found between intelligence measures and achievement in these subjects, and between intelligence measures and factors related to school work. Thus, Vandiver and Melcher (264) reported that brighter children do much more voluntary reading than do dull children. The distinct handicap of mentally defective children in the traditional school subjects is illustrated by the findings of Witty and McCafferty (284) on standard tests in a special school for such children. These children, with I. Q.'s between 55 and 71, were definitely below the M. A. norms in all subjects except arithmetic computation.

Bowman (23, 25) and Wheat (274) showed that the number concepts of bright children are more abstract and are freer of particularized content than are those of duller children, and both authors reported a fairly high correlation between I. Q. and problem-solving ability in this subject. The brightest children, according to Overman (205, 206), were especially capable of learning arithmetic on a rational as opposed to an automatic basis. Edwards (79) on the basis of careful error analyses and a comparison of I. Q.'s with scores on a test in percentage stated that the learning of this arithmetic topic is to be explained in terms of general ability, rather than as due to the operation of some special "mysterious" ability. On the other hand, Engelhart (80) by means of the path coefficient technic demonstrated that not more than 25.69 percent of the variance in arithmetic problem-solving ability can be attributed to variations in intelligence. Moreover, Norem and Knight (198) found little relation between I. Q. on the one hand and the learning of the multiplication combinations on the other, their measures of learning being the number of combinations known on the pre-test, the total number of errors in learning and in maintenance, etc. The lowness of the correlations may be due in part to variation in M. A. which goes back to variation in C. A. (chronological age) and to the small number of their subjects, the latter being from eight to ten years of age.

The number of studies in reading and spelling is much smaller. Sister Mary of the Visitation (183) and Pyle (218) found distinct advantages for superior children intellectually with respect to perceptual factors of importance in these two subjects. Dearborn (70) reported that bright and dull children are quite unlike in the nature of their erroneous concepts as

these are involved in reading. Likewise in spelling Carroll (43, 44) showed that the errors of bright and dull children are different. Their errors, for example, occur in different parts of the word and are due to phonetic generalizations in the case of the bright though not in the case of the dull children. The misspellings of the latter are much more erratic, as if made through guessing.

Bright children throughout the grades tend to articulate more rapidly than do dull children (69), to be only slightly better and slightly more rapid writers (283), but to be more varied in their sentence structure in English composition (215).

Comparatively Limited Achievement of Bright Children

A general tendency has been noted for those highest in I. Q. to work less nearly to capacity than do those less favored in intelligence. A. W. Brown and Lind (29) gave parts of the Stanford Achievement Test and special tests in drawing and writing to 153 children with I. Q.'s of 50 to 79 in one school and to 161 with I. Q.'s of 55 to 161 in another school. In both schools A. Q.'s (achievement quotients) decreased consistently with increase in I. Q. Kaulfers (145) in his study of high-school Spanish found the same condition—those with the higher I. Q.'s did not achieve proportionately as compared with those of lower I. Q.'s. Brown and Lind furthermore showed that a given I. Q. guarantees nothing as to A. Q.; the relation of I. Q. to A. Q. depends most largely upon its position with respect to other I. Q.'s in the given group.

Intelligence and Transfer, Application, Generalization

Four studies contain evidence of the close relation between what is called intelligence and the ability to see relationships, to apply principles, and so on. Reference has already been made to Carroll's analysis (43, 44) of the spelling errors of bright children, which from their nature suggested the greater reliance of these children upon their knowledge of phonetics, a knowledge which they made use of in spelling unfamiliar words, while the errors of the duller children, in general, betrayed no such transfer. Osburn and Drennan (203) trained a group of third-grade children in solving arithmetic problems which contained a limited number of "clues." After six weeks' practice, tests were given in which the problems contained new and quite different "clues" and special vocabulary difficulties. While all pupils showed transfer, the brightest ones (those in the upper half) showed a far greater amount of transfer. Overman (205, 206) studied with special care the relation of intelligence to transfer in early arithmetic learning. His results showed transfer to increase with intelligence level, regardless of the method of instruction, and to be especially large for the brighter children in the case of those instructional methods

which permitted them to capitalize on their special abilities to utilize relations. Waples and C. A. Stone (266) found that the brighter children were distinctly superior in the application of an algebraic principle.

The only study to go counter to the above four was made by Beito and Brueckner (16). These investigators discovered that the dullest children profited more than the brighter ones in learning the reverses of combinations without instruction. The small margin of difference, particularly in the light of the few children employed (nine dull children), may be responsible for a spurious conclusion.

Instructional Methods as Related to Brightness and Dullness

Eight studies have been reported which relate to instructional methods of particular value for duller children. Abelson (1) found that the Dalton plan, known to be effective with brighter children, was also effective with duller children. On the basis of an analysis of errors in the spelling of duller children Bennett (17) recommended the "old-fashioned ABC method" of teaching such children their letters. The value of written assignments in history varies with the pupil, according to Gorman and Morgan (98), being of largest value for the duller children and of little or no value for bright children. In science the dullest fourth of school children, unlike the middle half and the brightest fourth, profit most when the laboratory precedes the recitation period (103). The difficulties of slow-learning pupils in junior high-school reading have been studied by Hogoboom (128), who found certain special methods of instruction to possess considerable merit. Raguse (219) showed that in the first grade children may well be divided for instruction in reading, on the basis of intelligence scores, but that, since this device is not sufficient in itself, instruction must be adapted to differences in intelligence. Similar findings are presented by McElwee (171). Special methods in reading, which proved to be of value for mentally retarded first-grade children were described by Braem (26) and by Raybold (221).

A number of other investigations emphasize the dependence of instructional methods, in part at least, upon intelligence factors. One brief report (134) suggested that a given instructional method (in this case, sound pictures) may vary in effectiveness, not merely with the intelligence of the pupil, but also in terms of his sex. Hanna (117, 118) compared three methods of teaching children in grades four and seven to solve arithmetic problems. In grade four the brightest children did about equally well by all three methods; in grade seven, they did best either by their own individual methods or by a new method ("dependencies") taught them in the experiment. The dull children in grade four found this new method the most effective of the three, but in grade seven were more successful with their own methods. Overman (205, 206) taught simple addition by four methods. The brightest children profited especially from those in-

structional methods which stressed the rational side of number and of number combination. Weaver (272) stated that formal instruction, specifically designed to remove such errors in seventh-grade history as biased views, misplaced topics in reports, and fundamental misconceptions, is much more valuable with children of average or less intelligence than with bright children. In general, those methods which rely upon transfer, generalization, application of principles, and the like, or which give ample opportunity for special skills in these functions, may be expected to be more helpful to bright than to dull children.

Intelligence and Personality in Learning

Attention has already been called to the general failure of children of superior intelligence to work to the limit of their capacity (29, 145). Three other investigations contain data pertinent to the above topic. According to Hendrickson and Huskey (123) high intelligence is most effective as an aid to learning when a pupil is an ambivert, is less effective when he is an extrovert, and still less effective when he is an introvert. Contrary to certain popular psychological notions, Hollingworth and Gray (129) showed that children of small physique, when bright, do not "compensate" for their small size by unusual effort. This last study was limited to the findings of a single group of fifty children, all with I. Q.'s above 135. Turney (263) reported that measures of such traits as industry, ambition, dependability, and the like correlated high with each other at the high-school level, correlated low with intelligence and high with achievement. Such a conclusion illustrates the danger of purely correlational approaches to the study of this topic. It overlooks the fact that the subjects, being high-school students, were all very well selected with respect to intelligence and not at all selected, or very little selected, with respect to personality traits.

Intelligence and Retention

Bassett (14) presented data to show that retention and M. A. in eighth grade history are, on the average, correlated at about .37, retention being measured four, eight, twelve, and sixteen months after the initial instruction. Cuff (67) found similar facts regarding the relation between I. Q. of college students and retention of nonsense material. M. A. and retention of sense material in grades seven to twelve correlated, in a study by Dietze (73), about .55 when the test was given immediately after reading, .43 one day later, and so on down to .25 one hundred days later. Holding vocabulary or reading ability constant lowered the coefficients. Layton (159) investigated retention in high-school algebra. She found I. Q.'s correlated with knowledge and skill in this subject to the extent of .293. The coefficient was higher between I. Q. and problem solving than between I. Q. and "manipulative technic."

Intelligence and Preferences as They Affect Learning

Bowman (24, 25) presented convincing evidence that bright and dull children differ in the types of setting which they prefer in arithmetic problems. The bright children are much more attracted by strange and novel elements (such as the puzzle element) in problems; the duller ones select more conventional types. On the whole, however, he found, as did Wheat (274), that bright children are much less concerned than dull children with the descriptive material in problems. Kaulfers (143) and Oxley (207) agreed that of the three or four foreign languages taught in the high school, students of less intelligence tend to select Spanish. Sichler (234) found that when given an opportunity to select activities calling for "creative" endeavor as opposed to "reproduction" for the purposes of organizing school science programs, bright children exhibited only a slightly greater tendency than did the duller to select the creative types.

TRANSFER AND GENERALIZATION

Many studies have been made in the school subjects which have some bearing on the problem of transfer. It is very important, however, to point out certain limitations which may make the obvious interpretations more or less questionable. In many cases no adequate controls are exercised to determine the causes of the effects noted. Such studies are liable to the fallacy of *post hoc, ergo propter hoc.* Those interested in a fundamental theory of transfer may raise serious questions concerning studies in which the nature of the practiced function is not clearly defined or limited. In such cases a result may be interpreted as transfer when in reality it merely represents the ability of the subjects to improve in a given function by practice.

General Transfer

Anderson (4) studied the amount of transfer from each of five high school shop courses to each of the other four. The five courses were analyzed from the standpoints of tools used, materials used, operations, and products. The amount of transfer between subjects was found to be a function of the degree of similarity in these aspects. Archer (5, 6, 7) found large amounts of positive transfer in spelling when the new function involved the simple addition of a suffix to a previously learned form. The transfer was negative when the previously learned form had to be changed before adding the suffix, for example, dropping final e or doubling a consonant. He inferred that in either case transfer was merely generalization. Positive or negative transfer depended on whether or not the generalization was suitable in any given case. Essentially the same phenomenon in the case of problems in percentage was described by Edwards (79) as the continued use of previously learned habits. For example 3/2 was

called 1½ percent because in the study of fractions 3/2 had been learned to be 1½. McGeoch and McDonald (173) found that interference was a function of the similarity between the original and interpolated work, supporting a transfer theory of interference.

Effect of One Subject on Another

The differences between the amounts of transfer in various combinations of shop courses formed the basis for Anderson's suggested order in which the courses should be studied (4). Wakeham (265) found that students who had had high-school chemistry made only slightly (1 percent) better records in college chemistry than those who had not. The same advantage was shown for those who had had high-school physics over those who had not. Those who had had both chemistry and physics in high school showed an advantage of 2.5 percent. Other factors, such as the abilities of the students and their training in other subjects, were not studied. Somewhat larger effect of high-school chemistry was shown by Bray (27). The study of physics in high school had little effect on college chemistry, and those who had studied biology and general science actually made smaller gains than the average for the whole group studied. Here again other influences were not controlled. Hurd (133) in a similar study of achievement in college physics concluded that high-school physics had little influence. General science was found by Carpenter (42) to be superior to biology as preparation for physics and chemistry, both from the standpoint of quality of work and scientific interest. Cramer (63) found a carry-over from the study of general science to the special sciences in high schools.

Students who had general mathematics in the seventh and eighth grades were found by Stokes (241) to be superior in ninth-grade general mathematics to those who had had arithmetic in the seventh and eighth grades. No indication is given as to whether this is due to the superior general training of the general mathematics or to the similarity of topics in the two courses. A similar superiority of exploratory mathematics as a preparation for algebra found by Kohlbrenner and Walker (157) seemed to be due to the similarity of topics. This superiority decreased toward the end of the ninth grade when the topics became unlike those studied in exploratory mathematics. Crow and Dvorak (66) reported that students who had studied general mathematics did as well on standardized geometry tests, and somewhat better on algebra tests, than those who had studied algebra and geometry.

Talbott (255), in a correlation study, revealed no significant contribution of other high-school subjects to English. He concluded that the "best way to improve English is to give more English." According to Gatchel (93) the effect of an eight weeks' course in "How To Study" given to

students of medium and low mentality was reflected in improvement in their ranks in other high-school courses. Werner (273) showed both advantages and disadvantages of the study of foreign languages in their effects on English. Woody (288) found students who had had one year of French poorer in English vocabulary than those who had had Latin and those who had had no foreign language at all.

Effect of Courses on Other Functions

Broening (28) noted a marked improvement in literary appreciation as a result of instruction in literature. Since this was one of the objectives of the course, it is impossible to divorce instruction in literature from instruction in appreciation. One frequently avowed objective of mathematics, namely, reasoning ability, was not developed in the seventh-grade children studied by Monroe (191). In a large percent of the cases pupils did not reason at all. Many calculations seemed to be random, many others determined largely by habit. Kornhauser (158) showed a marked effect on the attitudes of students as a result of the study of economics. These changes were on points more or less closely related to the content of the course. In general, the course effected greater "decision" on the part of the students, and a trend toward liberalism. While courses in general psychology were found to have a considerable effect on superstitions, Lehman and Fenton (160) pointed out that we cannot depend on a wholesale transfer, and recommended that courses in psychology should detect the student's most glaring superstitions and make a direct attack on them. Moore (192) found the knowledge of scientific facts positively, though not perfectly, related to the ability to apply them. Both were related to the amount of science studied and also to the amount of general training. The material used for testing did not distinguish completely between the knowledge of facts and the ability to apply them.

Effect of One Practiced Function on Another

The effect of practice in specific arithmetic combinations on other combinations has been studied by Beito and Brueckner (16) and by Olander (201). Beito and Brueckner found complete transfer from such addition combinations as $\frac{7}{4}$ to $\frac{4}{7}$. Olander's study showed similar results, and showed almost as complete transfer in very simple combinations (involving 0 and 1) which had not been taught in either form. Overman (205, 206) found that learning to solve certain types of problems spread to other related problems. John (140) found that children taught the short-division form for simple problems, then taught the long-division form for more complex problems, tended to give up the short-division form even in problems in

which it should have been used. Bovee (22) noted that the introduction of large amounts of written work in foreign language was marked by a greater increase in reading score. It is very doubtful whether this is a phenomenon of transfer. Newlun (196) gave students a period of instruction in summarizing in history. Their ability to summarize in history was improved, as was their achievement in the mastery of facts and information. No effect was produced, however, on reading in general.

Applying Rules, Generalizing, etc., in School Learning

A number of studies have demonstrated the ability of school children to learn and apply rules in spelling, but they do not all imply an economy of learning spelling in this way. King (153) showed that children throughout the upper grades could understand and apply certain rules of spelling. Others did not seem to be profitable. No evidence was presented on the effect of these rules on everyday spelling, nor on the relative economy of spelling by rule. Trowbridge (260) found that children in the lower grades could learn and apply spelling rules, but no evidence of generalization was found in the spelling of high-school seniors. Archer (5) inferred from errors due to generalization that guidance in the making of generalizations would be valuable in place of some of the specific drill on the spelling of different forms. Carroll (43, 44) analyzed the spelling errors of bright and dull children, showing that many of the errors are due to phonetic generalization. This type of generalization accounted for a larger percent of the errors of bright than of dull children. Horn (130) also showed the wide variety of possible errors of this sort in certain words.

Mitchell (190) found that children do not necessarily make generalizations in arithmetic. Two lists of fifteen problems, identical except that one list was stated in general terms and the other list contained specific problems, yielded a correlation of only .52 in the seventh and eighth grades. It was also shown that the average score on the list of specific problems was 2.5 higher than on the list of general problems. Persing (213) found that high-school students do make the proper applications of gas laws. In a set of problems the correct application was made in 85 percent of the cases. Fifty-six percent of all the errors made were due to faulty calculation. Osburn and Drennan (203) found practice in arithmetic problem solving with one sort of "cues" increased ability to solve problems with entirely different "cues."

Symonds (248) studied a number of procedures which emphasized logical selection of correct grammatical forms. A combination of such procedures was of much greater benefit than mere repetition of the correct forms. The study of grammatical rules was of less benefit, however, than practice on choosing the correct forms.

Effect of Method on Generalizing

In general the studies in this field have indicated that transfer is not merely a function of the objective nature of materials, but rather a function of the mental processes of the children. Dorsey and Hopkins (75) studied the ability and inclination of students to apply information in a number of fields, including methods of study, knowledge of Latin, and knowledge of descriptive geometry. The application (transfer) was not made naturally, but when the students were told that they should make use of their information in the appropriate field, the transfer was made much more readily. J. N. Washburne (269) found that preview questions in social science which called for generalizations resulted in an improvement in generalizing which spread to facts not covered by these particular questions. Overman (205, 206) and Cluley (57) revealed wide differences in the amounts of transfer with different methods of instruction. In each of these studies the method of formal instruction without any aids to transfer was the least effective of all the methods used, although an appreciable amount of transfer was effected by this method. Hurd (133) interpreted the lack of transfer from high-school physics to college physics as due to a lack of emphasis on generalization in high school. Olander (201) found that a few minutes daily practice in generalizing yielded no results. He offered as an explanation that (a) the function studied was too narrow; (b) too little time was given to generalizing; and (c) the children were too immature.

Miscellaneous Studies

A number of studies, while not bearing directly on any of the above problems, have some significance concerning the problem of transfer and generalization. Brownell and Stretch (32) found that unfamiliarity with the problem situation tended to decrease the efficiency of children in problem solving. This effect is produced by interfering with the child's choice of operations. The interference occurred in only a small percent of the children, and those most affected were the least skilled in problem solving. These facts would indicate that in some children problem solving was a matter of method, in other children the problems were specific. Similar results were indicated by Bowman (23) in-so-far as preference and ability are related in different types of problems. The children of grades five to eight studied by Wheat (274) had apparently generalized the particular arithmetic processes studied. They were neither helped nor hindered by problems of the elaborate, imaginative type. Zyve (291) presented data on the extent of generalization in moral conduct. Children who were given general training on cheating improved in their honesty in marking their own papers, but not nearly as much as children who were taught specifically concerning honesty in marking papers. She concluded that a generalized discussion of such moral problems was not sufficient.

Summary

The most important results of the studies on transfer seem to be further evidence that:

1. Transfer does take place, sometimes in very large amounts.
2. Transfer may be positive or negative, depending on the consistency of the functions involved.
3. The amount of transfer depends on the relation between the materials studied, the nature of the instruction, and the abilities of the learners.

SPECIAL TYPES OF LEARNING

In this section are included those studies which deal with some special type of mental or motor process other than the ordinary material of the school subjects. In some cases the investigations involve materials of the curriculum, but interest here is chiefly in their contribution to the psychology of the types of mental processes involved.

Motor Skills—Conard and Offerman (60), Crider (64), Gates and H. Brown (94), and Turner (261), studied various aspects of manuscript writing, its ease of acquisition, speed, and quality. All of these studies except that of Gates and Brown showed manuscript writing to be somewhat superior in speed to cursive writing up to about the fifth grade. The difference reported by Gates and Brown is not pronounced in favor of cursive writing. Speed in manuscript writing is not produced at the expense of legibility. Manuscript writing is found to be easily acquired by both children and adults, and to cause no ill effects in the change from cursive writing. The whole and part methods of learning typewriting were investigated by Fleming (86). The results favored the whole method. A similar study was made by Lomax (163). Scheidemann and Colyer (231) attempted to train left-handed writers to use the right hand. The training was entirely successful in nine of ten cases. In all nine cases right-handedness persisted over the period of summer vacation. Rice (223) made an analysis of the movements in drawing. Hicks (124) studied the effects of specific and general practice on a motor skill. Mace (170) found that the size of the target influenced the accuracy in hitting a given point with darts. He interpreted this as an effect of the intention of the thrower. In the study of industrial arts Gunther (116) found that manipulative participation was an aid to the learning of the facts of the subject. Lorge (164) studied the effect of distributed practice in learning mirror-drawing.

Attitudes

Four studies are reported indicating success of various projects in forming and changing the attitudes of students. Increases in art appreciation as a result of the study of pictures was indicated by A. L. Miller (189)

and by Waymack and Hendrickson (271). Teaching literature was found by Broening (28) to be an effective means of developing literary appreciation. Peterson and Thurstone (214) showed school children a moving picture which was sympathetic to the Germans. Measures taken before and after showing indicated that the children's attitudes toward the Germans had been materially changed.

Vocabulary

According to O'Shea (204) mild interest in a book read is more conducive to vocabulary building than excessive interest or no interest at all. Eurich (81) showed that the vocabularies of college students can be materially increased by special training. Buswell and John (39) studied the growth of concepts representing the most important arithmetical terms. Other studies of vocabulary not referred to elsewhere are those of Baird (12) and Graham (99).

Vocal Ability

Dawson (69) indicated that children have not mastered articulation when they enter school. Rapid progress is made from grades one to three, and the rate is almost doubled from grades one to twelve. He suggested that the rate of articulation is an important determiner of speed of oral reading in the early grades. Jersild and Bienstock (138) showed much improvement in the vocal ability of three-year-old children as a result of training.

Problem Solving

In F. T. Wilson's study (280), involving the discovery and application of a principle in a drawing game, intelligence with mental age held constant, was a more important factor than age in determining the ability. Matheson (184) repeated Kohler's experiments on apes with children. Studies of problem solving in arithmetic, not listed elsewhere, were made by Adams (3), M. E. Brown (31), and Rolker (229). A number of other studies bearing on the psychology of problem solving in arithmetic will be found in the bibliography.

Miscellaneous Special Types of Learning

G. L. Freeman (90) concluded from a study of learning nonsense syllables that context is a necessary feature of associative formation. Association of meaningless items does not occur by mere repetition. Munkhoff's study (194) of shorthand and Hicks and Stewart's study (125) of children's learning associations were not available for review. Experimental studies of eye movements were made by Abernethy (2) in spelling, and by Ring and Bentley (227) in reading. Kellogg and Eagleson (151) re-

peated with negro children Gates's study of ability to recognize emotions in pictures of faces. The results were similar to those of Gates for white children. Crider (65) found that repeated translations effected no further improvement in Spanish over the first translation, in terms of grammatical and vocabulary errors. Newlun (196) reported the results of teaching children to summarize in history. Improvement was noted in fifth-grade children's ability to summarize. Seven weeks' special training in composition, reported by Lyman (165), resulted in children's becoming "language conscious," improvement in ability to plan compositions, and ability to avoid minor language errors. The effects were reflected in the quality of compositions. Winch (282) found that school children could remember specific dates better than centuries. Horton (132) studied the improvement of scientific ability through laboratory exercises in chemistry.

THE PERMANENCE OF LEARNING

Amount of Forgetting

A number of investigations have been made concerning the performance of college students in certain elementary-school subjects. No data are available on the levels of achievement reached during learning. Consequently, no exact quantitative statements of the amounts of forgetting can be made. The figures given are undoubtedly influenced largely by factors of selection. Nevertheless, they are of some interest concerning the retention of these subjects over long periods. In the various groups of college freshmen studied 43 percent were below the eighth-grade norm according to Carson and Wheeler (45); 42 percent according to Christofferson (53, 54); 21 percent in reading rate and 11.8 percent in reading comprehension according to Zeleny (290).

In another group of studies the amounts of various school subjects retained over specified lengths of time were measured. In various fundamental processes in arithmetic Osburn and Foltz (202) reported losses during summer vacation ranging from one-sixteenth to three-fifths of what was learned from October to April. Kennedy (152) measured the retention of certain syntactical principles by first- and second-year Latin students. From 66 to 85 percent of the correct responses were retained over summer vacation, and from 54 to 68 percent were retained over one year. Greene (102) found that college students who took courses in zoology, psychology, and physiological chemistry lost approximately one-half of what they had learned in the elementary courses, during the summer vacation. The amount of zoology lost in one year varied from 20 to 40 percent in Cederstrom's study (48). Hurd (133) reported that students from one to three years removed from their course in high-school physics made scores on a physics test "distinctly" higher than those who had not had physics. No data are given to show how much they had known on completing the high-school course. P. O. Johnson (142) found that his

students lost approximately one-half of their knowledge of elementary botany in three months, another fourth in twelve more months, and very little from the fifteenth to twenty-seventh months. Layton (159) reported an average loss of 34 percent of the amount learned in elementary algebra, during one year in which no mathematics was studied. Almost complete retention over a period of two years was found by Goodenough and Tinker (97) in their study of mirror-drawing.

Relative Retention of Different Kinds of Material

F. N. Freeman and Abernethy (88, 89) studied the retention of typewriting and substitution where similar material was used. There was little difference in retention over a period of two weeks, but at the end of ten weeks there was a marked superiority in the retention of typewriting. The overt movements in typewriting are interpreted as helping to fix the learning. They concluded that comparatively early reviews are necessary in ideational learning, whereas they may be omitted without any great loss in motor learning. On the other hand, results reported by McGeoch (172) indicate superior retention for memorial materials over acts of skill. The materials were, however, not strictly comparable. Grant (100) found that intelligence is a more important factor in determining retention of meaningful material than meaningless material.

Practice Necessary for Mastery and Maintenance

Cuff (67) studied the effect of overlearning on retention. In remembering a simple series, overlearning effected relatively less saving in relearning after twenty-four hours than the same amounts of practice in learning. No indication is given of the effect of overlearning on the retention over long periods of time. Kennedy (152) found that one month's study in the fall was sufficient to relearn the principles of Latin syntax forgotten in the summer. A similar amount of study brought 65 percent of Carson and Wheeler's students above the eighth-grade level in arithmetic (45). Two hours per week for two months brought all of Christofferson's students above the eighth-grade level (53). Osburn and Foltz's study (202) in arithmetic showed that forgetting was greater in those operations which were learned late, thus indicating that students had not had time to practice sufficiently to maintain these skills. Senour (232) found that a distribution of study and tests over one week was sufficient to effect retention in spelling of 94 percent and 92 percent over periods of one month and four months respectively. Coit (58) gave high-school and college students ten minutes' remedial drill per day for ten days on some elementary facts of arithmetic and algebra. Practically complete retention was noted one month after practice ceased. Similarly, McCallister (167) found that gains effected by remedial instruction in reading were retained almost completely for six to nine months.

Factors Influencing Retention

P. O. Johnson (142) reported that better students in botany not only retained larger amounts than poorer students, but also larger percents of what they had learned. Cederstrom (48), on the other hand, found that the percent of zoology retained was but slightly related to percentile ratings on college aptitude tests, while the amount retained seemed related to the ratings on the college aptitude test to only a small extent. Dietze (73), Grant (100), and Osburn and Foltz (202) reported positive relations between intelligence and retention. The evidence supports the view that fast learners are not fast forgetters, although the relation between learning and forgetting is not nearly perfect. Bassett (14) found retention in history related, in the order of extent, to interest and effort, history understanding, reading comprehension, mental age, and subject preference. The coefficients of correlation (r) ranged from .66 to .359. No partial analysis was made. Various conditions of learning and recall have been studied. Thisted and Remmers (256) found that the anticipation of a test improved retention of vocabularies only slightly. The marking of hard spots in spelling in Tireman's study (258) not only failed to increase retention, but produced a decrease in permanent recall. Burri (37) found that the presence of an audience had a disturbing effect on recall. The kind of audience, attentive or inattentive made little difference. In a study of the process of addition Sister Mary Immaculata (182) indicated that retention was a function of the distribution of practice, very short practice periods being better. The effect of repetitions on retention was studied by Cuff (67) and Coulter (61). Stoddard (240) found that in retaining the English equivalents of a French vocabulary recall in the order French-English was very superior to recall in the order English-French, with the order of learning constant. With the order of recall constant, no difference was noted between the effectiveness of the two learning orders. Each learning method was better for the same method of recall than was the other learning method.

Curves of Forgetting

While very few of the studies include curves of forgetting, a number of them give data on the amounts of forgetting for various periods, from which curves may be inferred. In general, those studies which report a series of measures indicate a course similar to the traditional curve of forgetting (72, 100, 142, 152, 232). Seven of Grant's curves are reported as being of the Ebbinghaus type and three as definitely not of this type, but no data are given on any of them, and no statement as to what the other three are like. A few studies report practically complete retention over a period of time. This would indicate that the forgetting curve, if further measurements had been made, could not have been negatively accelerated (45, 97, 167).

Early Experiences—the Beginnings of Particular Types of Behavior

There is a large and rapidly growing literature on the appearance and genetic development of fundamental types of behavior, both that behavior which is and that which is not of immediate significance for formal education. Only a few samples of the former type are included here, largely for purposes of illustration. Three are investigations on language behavior, made by Betzner (19), who studied the dictated compositions of 1215 children aged five to eight; by McCarthy (169), who studied language in the pre-school child; and by Strayer (244), who studied maturation as compared with systematic language instruction in the case of year-and-a-half-old identical twins. In addition, Jenkins (136) tested 321 children, aged five to seven, on various forms of motor achievement and Farwell (85) reported data on the use of constructive play materials in the kindergarten and first two grades.

The studies of early experience which are most directly related to education are those which describe and analyze the equipment of children to profit from consistent instruction in particular fields. Here belong the various investigations which study "readiness"—in the case of arithmetic, the investigations by Buckingham (34), Buckingham and MacLatchy (35), Gillet (96), MacLatchy (175, 176, 177, 178), C. W. Washburne (267, 268), and Woody (286, 287, 289); in the case of reading, those by Deputy (71) and by Morphett and C. W. Washburne (193).

Learning as Related to Age Beyond School Limits

Cheydleur (52) and Fraser and Crawford (87) reported studies comparing the success of college students and of older adults, beyond normal college age, in learning a foreign language. Sorenson (237) studied the same comparison in learning the content of a course in education. The evidence is particularly striking in the Cheydleur and Sorenson studies that the non-college adults were not severely handicapped, though Sorenson indicated that success probably comes harder after 50 and is especially hard to win in the case of those who, since their formal schooling, have neglected study activities.

Growth in Educational Abilities

The study by Hildreth (126) is the only one of the studies classed under this heading which is based upon the periodic measurements of the same children. In the other studies the measures of growth reported were in all cases derived from different groups of children at the successive ages, on the assumption that a group of ten-year-old pupils represent what a group of nine-year-olds will be next year and what a group of eleven-year-olds were last year.

Within limits, any study which reports norms on tests or on types of educational subjectmatter is a study of growth of educational ability. Thus, Conard (59) gave age standards for manuscript writing by pen and by pencil, and Kaulfers (144) gave mental age norms for a test of Spanish vocabulary and for a test of silent reading in Spanish.

Growth of mathematical vocabulary was studied by Pressey and Moore (216) and in greater detail and with greater thoroughness by Buswell and John (39). Growth in various aspects of English ability was traced by Symonds and his students: punctuation (249), capitalization (250), vocabulary (251), sentence structure (252), and grammar (253). One investigation (106) reported data on the development, from grade three to grade six, of the ability to interpret stories and poems through reading, to select essential facts, and to understand exact directions. Book and Harter (21) showed, for the elementary grades, for the high school, and for the college, the types of spelling mistakes and the comparative importance of underlying causes. Spelling at the college level was also investigated by Hartmann (121). Failing to give due weight to the fact of selective elimination he interpreted the increase in the average score of sophomores to signify an increase in ability from freshman to sophomore year. Hildreth (126) presented data and curves to show growth in three school subjects for forty-two children as a group and for four individual children. Growth in this case was determined by annual testings over a period of eight years. On the basis of findings from 909 children, Knauber (154) described the development of drawing ability from the kindergarten through the primary grades. Newland (195) revealed the variation in the illegibility of written Arabic digits with age, and Wittler (283) reported the changes in rate and quality of handwriting from grade three to grade six. Increase in rate of articulation through the twelve grades of the public school was studied by Dawson (69), and the improvement of quality in drawings was investigated by Rice (223) through a study of the types of movements made in their execution.

PREDICTION AND PROGNOSIS

The references cited here do not include all those which reported correlations between various learning functions and other variables, or those which compare the progress of certain classified groups. Only those studies are included which give some indication of the value, or lack of it, of certain instruments for forecasting the progress of individuals. Obviously, measures which are derived during or after the course of learning could not be of value in predicting. The results which do have a bearing on prediction are, in the main, negative. No new types of instruments of prediction are revealed, and the traditional methods of forecasting are generally shown to be of little value in individual cases, and of only slight value in predicting the success of broad classifications.

Garretson (92) made a study of the preferences of students for various kinds of activities. Such preferences, as measured by a questionnaire, correlated to the extent of .560 with subsequent enrolment in academic subjects, .725 with commercial subjects, and .869 with technical subjects. Preference was, however, of no value in predicting the marks made by students in the various curricula. Kaulfers (147) found that intelligence and achievement in Spanish were correlated to the extent of .42 for boys and .53 for girls. In a similar report (145) he showed that the trend in grades for various levels of intelligence is not entirely regular. In spite of this irregularity, which he explained as due to a combination of other factors than intelligence, he (146) concluded that pupils with I. Q.'s below 105 are "bad risks" in Spanish. It should be noted that 50 percent of the boys failing Spanish and 25 percent of the failing girls were above this level; and that 25 percent of the girls passing and 50 percent of the boys passing were below this level. Kaulfers' results (149) also indicated that English marks were of little value in predicting success in Spanish. As a result of his study of high-school marks Maller (181) suggested that neither age nor mental age is of any value for individual prognosis, but that they may be of some value for group classification. He recommends the use of age for classification, rather than mental age, for the better equation of physiological factors and to eliminate social friction. The correlation between intelligence and first-grade reading achievement was .70 in the group studied by Deputy (71). The retention of college zoology was reported by Cederstrom (48) to be only slightly related to ratings on a college aptitude test. Dilley (74) found that of students falling below an arbitrary level called failure on the Ohio Psychological Examination (3.6 percent to 18 percent of the entrants for various years) no one made an A average in college, only a few made B averages, and 20 percent to 32 percent (for the various years) made C averages. Such a test, he pointed out, is adequate for locating a group which will not be in the higher scholarship ranks, but is not adequate for excluding the whole group of failures, since a considerable number of them made satisfactory records.

Symonds (247) reported a foreign language prognosis test, composed of English, Esperanto, and an artificial language, which yielded correlations with achievement in French, Latin, and Spanish, averaging .60 for one form of the test and .71 for two forms. These correlations, he pointed out, are higher than those usually found with intelligence.

Knight and Manuel (156) found that children entering school at seven years of age take slightly longer to finish the eleven grades, and made slightly lower grades in high school than children entering at six. The differences are not large enough, however, to be of much significance compared to other factors which may exist in individual cases. Intelligence, as estimated by Haggerty's method from parental occupation, was identical for the two groups. Hartmann (122), in a study of speed in reciting variations of the alphabet, found initial performance correlated .60 with

achievement. Wakeham (265) reported data which indicated that the study of science in high school did not forecast superior achievement in college chemistry.

ANALYSES OF ERRORS

Fifty-eight references are included in the bibliography on analyses of errors. This total does not include (1) purely theoretical descriptions and interpretations of error or (2) studies of individual cases of disability, unless the investigator summarizes and classifies the errors found into distinct categories. Case studies are treated under a separate heading, "Special Disability," p. 307. There are included, however, seven references (18, 55, 58, 228, 254, 262, 270) whose titles indicate error studies, but which were not available for criticism. These references are classified in the paragraphs below, but their findings are not, of course, reported. There are also included in the bibliography several articles in which the investigator clearly regarded his error analyses as of subordinate importance to his major problem. These studies are reviewed for the purpose of illustrating valuable uses of error analyses other than those for which they are customarily employed.

Subjects in Which Studies of Errors Were Made

Five of the studies were made in first-year algebra:

Benz (18)
Coit (58)
Clem and Hendershot (56)
MacRae and Uhl (180)
Pease (210)

Sixteen were made in arithmetic:

Burge (36)
Chase (51)
Georges (95)
Monroe (191)
Overman (205)
Christofferson (54)
Coit (58)
Guiler (114)
Newland (195)
Renwick (222)
Christofferson, Clinton, and Wood (55)
Edwards (79)
John (139, 140)
Knight and Ford (155)
Waterson and Unruh (270)

One was made in drawing: Rice (224).

Eighteen were made in English:

Arnold (9)
Harap (120)
Matravers (185)
Turney and Ummel (262)
Chapman (50)
Leonard (162)
Rodgers (228)
Guiler (107, 108, 109, 110, 111, 112, 113)
Symonds (249, 250, 252, 253)

One was made in Latin: Taber (254).

Ten were made in reading:

Birdsall (20)
Dearborn (70)
Payne (209)
Camp (41)
Georges (95)
Tinker and Goodenough (257)
Camp and Allen (40)
McCallister (166, 167, 168)

One was made in science: Persing (213).

Six were made in spelling:

Abernethy (2)	Ashbaugh (10)	Book and Harter (21)
Carroll (43)	Horn (130)	Mendenhall (188)

Three were made in writing:

Bennett (17)	Guiler (115)	Newland (195)

The total of these references is sixty-one, due to the fact that three of the studies (58, 95, 195) involved two school subjects and are, therefore, repeated in the classification.

Level of Analysis as Shown by Categories Reported

These fifty-eight studies differ markedly in the detail and depth to which analysis was carried—in the specificity and nature of the items cataloged and reported.

One extreme may be illustrated by the study reported by Clem and Hendershot (56) in problem-solving in first-year algebra. In their report five classes of error are listed as having been found on test papers. These classes are of the type: "Problem solving depends on problem reading," "Inability to do logical reasoning, as would be expected, proved to be a significant factor in producing errors," and so on. The frequency of errors of the different classes is not given, nor are data reported to show the basis for deriving these classes or errors.

There is, second, a larger group of studies in which the categories are more distinct, in which comparative frequencies are reported, but in which analysis stops short at this point—with a tabulation. Thus, Coit (58) reported the number of erroneous solutions on a test of forty items of arithmetic and algebra, given to high-school and college students. Guiler published a series of such articles in the field of English (107, 108, 109, 110, 111, 112, 113).

There is, third, a more penetrating type of error analysis. Here the investigator goes beyond a mere cataloging of errors and concerns himself with fundamental issues in teaching and learning, such as the nature of errors, causal factors, and the like. The findings of thirty such studies will be summarized at a later point.

Technics Employed in Analyses

Six rather distinct methods of securing data on errors are represented in the studies summarized in this section.

1. The method of compilation was used once, by Harap (120), in bringing together the findings of a number of original investigations made by others in English.

2. By far the most popular method is that of analyzing typical samples or products of pupils' work, such as test papers, themes, daily assignments, and the like. This

method was employed thirty-eight times, being combined with other technics in only five of these thirty-one studies. Among this list of studies there is the greatest variation in quality. Thus, Chapman (50) simply cataloged errors in themes in a routine fashion, placing them in fifteen categories, while Carroll (43) studied errors in spelling in connection with the intelligence of the speller and brought out striking differences as between bright and dull children's methods of procedure.

3. Special diagnostic tests were designed and used, or such tests designed by others were used, in ten studies. In the case of several of these, for example, Guiler (110), the supposedly superior instrument failed to yield data which could not have been obtained by analyzing daily products of the classroom.

4. In twelve studies the behavior of children was directly observed as they worked under conditions approximating those of the classroom. Thus, Chase (51) and John (139) observed children's difficulties in problem-solving in arithmetic by noting significant items in their behavior and in the reports of their processes. Other examples of this technic are furnished by Birdsall (20), Burge (36), Dearborn (70), Guiler (114), John (140), McCallister (166, 167, 168), Matravers (185), and Renwick (222).

5. Laboratory technics were employed in five studies. Thus, Tinker and Goodenough (257) studied errors in reading by making careful records of the difficulties encountered by adults in learning mirror-reading. Payne (209) used a tachistoscope to learn something of children's difficulties in perceiving words and phrases. Abernethy (2) photographed eye-movements to compare the procedures of good and poor spellers. Other studies made by laboratory technics are those by McCallister in reading at the junior high-school level (166, 167).

6. Children were interviewed and questioned in twelve studies; namely, those of Birdsall (20), Burge (36), Camp (41), Camp and Allen (40), Chase (51), Guiler (114), John (139, 140), McCallister (166, 167, 168), and Renwick (222).

In general the data on errors obtained by the last three technics are more impressive, both with respect to their apparent authenticity and with respect to their significance for teaching and learning. The analysis of pupils' papers requires inference to a dangerous degree. The investigator must deduce the nature and cause of error from an ambiguous record. To a less extent the same danger is inherent in the use of special diagnostic tests. Direct observation and questioning permit the investigator to study the error in its relation to other possibly important features of the situation and thus to assure him some degree of perspective in interpretation. Laboratory technics are especially valuable in isolating those aspects of behavior of which the study is being made. Nevertheless, nothing in a given technic guarantees success in its use; less direct technics, when expertly managed, yield more valuable data than do direct technics which are poorly controlled.

Findings of Error Analyses

For the purpose of summarizing their findings and demonstrating their uses the thirty most careful of the available error analyses are grouped under three heads.

Nature of Error in the Different School Subjects—Five studies reported important data on the nature of the thought-processes which lead to error in arithmetic. (See also Nos. 54, 79, 155, and 205 as summarized on

this page.) Burge (36) analyzed approximately 500 test papers and reports interviews with approximately 2100 fourth- and fifth-grade children with respect to errors in multiplication. He listed a total of sixty-eight different "types of errors and questionable habits of work" which are responsible for difficulty in this process. Georges (95) analyzed 188 reports submitted by junior high-school pupils and presented a list of six basic sources of difficulty in reading mathematics, together with lists of particular words, symbols, and relationships which cause the most trouble. John (139) reported forty specific types of errors in arithmetic problem-solving, obtained by interviewing the five best and the five poorest arithmetic pupils in grades four and five in two schools. John (140) also made use of the same technic to isolate the causes of difficulty in long division. Monroe (191) by classifying kinds of erroneous solutions to sets of arithmetic problems was able to show that children in grade seven tend to react to problems less by reasoning than by chance or habitual responses.

Guiler (115) subjected the handwriting of fourteen pupils in grades seven and eight to careful diagnosis, not only in terms of the usual items of slant, letter formation, and the like, but in terms of particular letters and combinations of letters. The writing of subnormal children was studied by Bennett (17), who discovered that letters differ widely in correctness of design. Newland (195) analyzed the specific illegibilities of the Arabic digits, utilizing 135,000 digits written by 1127 different people under all sorts of conditions.

The mental processes of good and poor readers in grade seven are compared by Birdsall (20). Camp (41) evaluated a program of instruction in oral reading largely by means of comparing the change in errors made on the Gray Oral Reading Check Tests. Dearborn (70) analyzed in detail the errors reported by teachers of reading in grades three and four. In three studies McCallister (166, 167, 168) presented important data on reading errors in the junior high school.

The eye-movements of good and poor and of mature and immature spellers were compared by Abernethy (2). Book and Harter (21) collected misspellings from grade two through the college and traced the 18,840 mistakes, by deduction, to the operation of eighteen fundamental types of error.

Factors Making for Error—(a) Transfer of training has been shown to result at times in a carry-over of errors instead of or along with the carrying over of desirable responses. Many errors in percentage were shown by Edwards (79) to be due to interference from knowledge of common fractions. Errors in addition and subtraction were traced by Overman (205) to carry-over from earlier learnings. Likewise, in reading many types of error were identified by Dearborn (70), Payne (209), and Tinker and Goodenough (257) as the effect of harmful transfer. Similarly errors in spelling may frequently be caused by interference (21, 43, 130). (b) Disuse of a function (computation) was shown by Christofferson (54) to be a

cause of error (in arithmetic problem-solving). (c) Particular conditions of use may lead to errors in a given function. Thus, Knight and Ford (155) showed that the correctness of a given multiplication, for example, is conditioned by its "depth" in the example. Mendenhall (188) by analyzing spelling papers demonstrated that place in the word is closely associated with the number of errors made and that the "hard spots" tend to be located toward the middle of the word. (d) Ashbaugh (10) presented data which minimize greatly the supposed seriousness of the *initial error* in learning. Of a total of 519 "initial" misspellings on a list of 3840 words in the pre-tests only twenty-eight appeared five days later.

Research Uses—(a) Symonds and his assistants (249, 250, 252, 253) made use of error frequencies as a means of plotting growth in various phases of English ability—punctuation, capitalization, sentence structure, and grammar. A total of 616 compositions, previously rated by the Hillegas scale in earlier investigations, provided the basic data, which were utilized on the assumption, recognized as such, that differences in grade and age levels correspond to differences in quality scores as expressed in terms of the scale norms. (b) Error analyses were also employed as one method of evaluating instructional technics and the organization of instructional materials by Camp (41), John (140), and McCallister (167).

Criticism and Conclusion

Attention has several times been called to the difference in value of the error analyses reviewed in the foregoing paragraphs. Too many of them represent ends in themselves and make no contribution to an understanding of the learning process or to the direction of the teaching process. Of course, the data in such studies do show points of difficulty in learning and items which need to be re-taught and, with the next group of children, to be better taught. But too frequently the data contain no suggestion as to *why children encounter these difficulties,* as to *the precise nature of the difficulties,* and as to *how these difficulties may be avoided.*

The differences in the quality of the error studies are due in part to the type of technic employed, in part to the skill and insight with which the technic is used, and in part to the nature of the subjectmatter in which the investigation is made. There seems to be little justification for multiplying further the catalogs of errors now in print. In general it would appear to be wise to substitute the more searching technics of the interview, of the laboratory, and of direct observation for the less revealing technics of compilation and for the analysis of daily products and of the data secured by specially devised tests.

Some of the school subjects are more open to penetrating examination than are others. Thus, handwriting and oral reading are especially capable of being objectively studied. Arithmetic, which on the surface seems to be a rather hopeless field, has, as the result of the application of appropriate technics, yielded to research and is rapidly becoming one of the better un-

derstood subjects from the standpoint of the psychology of learning. At the other extreme, it will perhaps have been noted that certain subjects, such as geography, do not appear at all among those for which error analyses were available for the period of this summary, while other subjects, such as English, in which studies have been made, have suffered from superficial analysis and inadequate interpretation with regard to learning.

SPECIAL DISABILITY

Under this heading only those studies are summarized which report investigations (1) into special disability in the various school subjects, and (2) in the case of particular individuals. That is to say, this section is confined to case studies; more general studies of disability in learning are reviewed under the headings "Analyses of Errors", "General Ability and Learning", and "Diagnostic and Remedial Teaching." Case studies such as Hirsch (127) described, in which the source of difficulty is one of personality maladjustment, have been omitted as being hardly appropriate material for this issue of the *Review*. A study of seven cases of disability in algebra was reported by MacRae and Uhl (180). Special disability in arithmetic was studied by Baker (13), Chase (51), Evans (84), Gabbert (91), McMaster (179), Soth (238), Trousdale (259), and Whitson (275). Special disability in reading was investigated by Baker (13), Carter (46, 47), Dougherty (76), Dreis (77), McMaster (179), Rigby (226), and C. R. Stone (243). Difficulty in learning to spell was analyzed in the reports of Baker (13) and McGovney (174). Baker (13) studied special disability in handwriting. The most ambitious report on disability is that by Baker (13), in which data are presented on 20 cases of disability in a single subject, 12 cases in two subjects, and 8 cases in three subjects.

Summary

The value of the above studies lies chiefly in their detail and in their interpretations of the relations between the measures employed. On this account it is virtually impossible to organize the findings of the investigations in a helpful way and yet retain the separateness of the studies. With the exception of those reported by Baker (13) and of four others to be mentioned, each study stands as a unit and needs to be treated as such. These last four exceptions (84, 91, 259, 275) have been summarized as a group by Brownell (33), who explained the technics employed and the theory and interpretations of the measures obtained insofar as these are common to the four.

The reading of the separate studies leaves certain impressions regarding the phenomenon of special disability:

1. Special disability is no longer regarded as a consequence of, or evidence of, low intelligence, but it may be found associated with a high I. Q. and with marked excellence in fields other than that of the disability.

2. Special disability, at least in the school subjects, is rarely if ever inherited as such.

3. Special disability seems rather to be the product of unfortunate circumstances of poor instruction, lack of interest, and the like.

4. Special disability tends to disappear with careful diagnosis and equally careful instruction; although low intelligence, and sometimes, even *high* intelligence, as shown by Evans (84), plus long-continued disability, impede progress and recovery.

5. Special disability is most fruitfully investigated in its immediate manifestations rather than through the evidence to be had from measures of other functions only indirectly related to the disability. See for example, some of the cases in Baker (13) in which elaborate measurements are made, only to be disregarded in the diagnosis and remedial treatment of the cases.

SEX DIFFERENCES

The studies reviewed under this heading are divided into three groups on the basis of the importance attached to the problem of sex differences.

Incidental Reference to Sex Differences

In eleven studies sex differences are discussed in a purely incidental manner. In four of these investigations the sexes were found to be essentially equal in learning, as measured by the average number (though not the kinds) of errors in English composition (50); the effect of additional repetitions on the memorization of simple series (67); number of errors in learning the Goddard formboard (277); and recall of the digits upon the presentation of the symbols in the Army Beta substitution test (276).

In eight other studies varying degrees of inequality were reported for the sexes. F. J. Brown (30) secured some slight evidence that boys profited more than girls from the incentive he used in teaching arithmetic. Buckingham and MacLatchy (35) gave convincing data to prove the general superiority of girls over boys in number knowledge at the time of entering school. The same data and the same conclusions were reported in Kaulfers' three articles (145, 146, 147) to the effect that girls work more nearly to their capacity in Spanish than do boys, and that in the case of the latter failure in the subject is less apt to be due to inadequate intelligence. In another study by the same author (144) it was shown that the mental age norms for girls were higher than those for boys on a standard vocabulary and a silent reading test in Spanish. F. T. Wilson (280) seemed to discover some differences in the way in which boys and girls learned a game requiring the formulation of a principle for success, but the small number of his subjects may easily account for the apparent differences.

Sex Differences as a Subsidiary Problem

Ten investigators have been interested in sex differences, not as their major problem, but as a matter of importance and of direct significance for their major problem. One report (134) found inconsistent differences in

the degree to which boys and girls acquired information from sound pictures. In the case of the retention of history material in grades six to eight, Bassett (14) reported that data for eighty-five boys, carefully equated with as many girls on the basis of three important criteria, established superiority for the boys whether retention was measured four, eight, twelve, or sixteen weeks after instruction. According to Bowman (23, 24) boys and girls in the junior high school differ somewhat in their preference for and performance on arithmetic problems containing five kinds of settings, girls showing a preference for problems of the "puzzle and pure computation types," whereas boys show a greater degree of preference for the "adult, child, and science types." In college chemistry Bray (27) found a reliable difference in favor of men both in their initial and in their final knowledge of the subject. A large part of their superiority was ascribed to their having elected chemistry, while for the girls the subject was required. In learning English and nonsense words A. J. Davis and Meenes (68) discovered that men (fifty-seven in number) and women (forty-seven in number) learned equally well by the part method, but that men were superior to women when the whole method was prescribed. Dawson (69) determined that girls' rate of articulation is faster than is boys' up to the age of twelve or thirteen, after which the boys' rate is consistently faster. Hendrickson and Huskey (123) found that grammar-grade girls, who as a class were somewhat more introverted than the boys in the same grades, were affected similarly by this trait, as well as by ambiversion and extroversion, in their school achievement. Overman (205) could find no statistically reliable difference in the degree to which the boys and girls of his experiment employed transfer of training in simple arithmetical learning and could find only a slight difference in their reactions to the four methods of teaching employed. A slight but unreliable difference in favor of boys was reported by Stokes (242) in the degree to which they applied themselves to the study of ninth grade mathematics. According to data collected by Wittler (283) girls' I. Q.'s in the intermediate grades correlate higher with rate and quality of handwriting than do boys'.

Sex Differences as the Major Problem

Nine studies have been reported in which the major problem was sex as a factor in learning. Seven of these may be described as routine investigations. Atkinson (11) found that on eight general science tests 57 percent of the boys, in spite of a slight I. Q. disadvantage, equalled or exceeded the girls' median score. Bassett's data (14, 15) on retention in history have been described previously. According to B. L. Johnson (141) the 888 boys and the 968 girls employed, in grades five to eleven, did not differ in the total amount of their reading, though they did differ in the kinds of their reading. Meltzer and Bailor (186) gave evidence from a small number of

cases that women surpass men in learning the content of psychology. In an investigation by Pease (211) girls (an average number of 184) surpassed boys (an average number of 161) in twenty-two of twenty-three tests given in algebra and made considerably fewer errors in these tests in spite of the fact that they were probably less carefully selected as to intelligence. Witty and Lehman (285) reported the typical sorts of evidence (average test scores and number of failures) to show that girls in the junior high school are superior to boys in their achievement. Armstrong (8) gave boys and girls, numbering 271 and 200 respectively various types of intelligence tests—verbal, non-verbal, and performance; no important differences in I. Q. were discovered, though the sexes were found to differ in their success with particular tasks.

Two reports in this group deserve more careful attention. Hanske (119) studied sex differences in high-school chemistry. Test results showed that the 125 boys surpassed the 105 girls in fifteen of the eighteen tests, but certainly so in only two, and probably so in six more. Further analysis revealed this apparent superiority to be unreal, so far as capacity to learn the subject was concerned: the girls were found to average five months younger and to be at a marked disadvantage in their background in science. Perry (212) likewise refused to stop with the first evidence of superiority for boys on her geometry tests. Her findings are limited by the fact that she employed only fifty-three boys and thirty-six girls, selected from classes average, good, and superior in quality, but her search for an explanation of her first conclusion is entirely commendable. Detailed statistical treatment, perhaps unjustified by the small number of cases, revealed superiority for the girls in fundamental types of thinking which were more important for learning than were their test scores.

Conclusion—The topic of sex differences is at present much less attractive to investigators than it was formerly. In those of the studies here summarized in which differences were found to exist, the amount of the differences is reported as small. Furthermore, when differences are discovered, there is evident now much less of a tendency than formerly to account for the differences in terms of heredity, and much more of a tendency to look for the explanation to dissimilarities in environmental factors and in social pressure. In only one (276) of the above studies was inheritance cited as the basic cause, and in this study the evidence is exceedingly meager: the abilities involved in learning the digit-symbol substitution tests are supposed, on the basis of correlations for nineteen pairs of cases and of the consistency of this finding with other measures equally as insignificant, to be inherited according to the Mendelian pattern.

CONSTITUTION OF ABILITY

Several of the earlier sections of this chapter have summarized material of importance with respect to the above topic. Particular reference should

be made to: (1) "General Ability and Learning" (especially, the paragraphs on the first five topics), (2) "Transfer and Generalization" (all), (3) "Analyses of Errors" (especially "Findings of Error Analyses"), and (4) "Sex Differences." In order to avoid repetition only those studies under this topic which have not been previously described will here receive detailed attention.

Nature of Ability Itself

Ashbaugh (10) showed the relative insignificance of "initial errors" in learning spelling. Christofferson (54) emphasized the fact that within a large ability (such as arithmetic problem-solving) efficiency of the whole may suffer from the disuse of a minor part. Transfer of training has been found to be a highly important factor in the organization of ability (4, 43, 44, 200, 201). Place, time, and other special conditions of the exercise of some subsidiary part of a larger ability is known to alter greatly the operation of that ability (155, 187). Lennes and Fee (161), employing six consecutive test papers of 135 children in grade seven, analyzed the variability of individual pupils in the four fundamental operations with integers. Their data revealed surprising inconsistencies and variable levels of achievement from test to test, thus further illustrating the instability of the functions measured and their sensitiveness to unknown but important changes in circumstances.

Nature of Specific Abilities as Revealed Indirectly Through the Study of Special Disability

Important information regarding the nature of ability in the various school subjects has been gained from the study of special disability in these subjects. Test papers and other products of pupils' daily work have been frequently analyzed for such knowledge, for example, by Book and Harter (21) in spelling and by Georges (95) in the reading of junior high-school mathematics. Many case studies have been reported; the masses of more or less relevant data which have been brought together to permit the detailed study of individual cases have also served to shed light on the constitution of ability in the type of learning in question, for example, by Baker (13) in various subjects and by Gabbert (91) in arithmetic. Individual children have been observed at work and have been interviewed as to their processes in the hope of discovering more concerning the composition of specific school abilities by Burge (36) and John (139) in arithmetic, and by Birdsall (20) in reading. And finally, statistical comparisons and analyses of disabilities have been employed as still another means of securing such information, as, for instance, Poley (215) in English composition. In this last class of study too belongs an investigation by Kay (150) who found, by statistical comparison, a positive relation between errors in pronouncing and in spelling words.

Nature of Specific Abilities as Revealed through Direct Study

A large number of studies have been made (summarized in Chapter II of this *Review*) primarily for the purpose of evaluating certain instructional technics and certain types of organization of instructional materials; but these studies have also, by reason of their character, revealed something concerning the nature of the various abilities involved and something regarding their relations to other abilities. Of this kind of study two only may be cited here as samples. Shriner (233) reported the results obtained in an investigation with 1191 children in which drill was given in reading verbal arithmetic problems. His data suggest important relations between the subjects of reading and arithmetic. In a similar study, Stretch (245), making use of the control-group technic of experimentation, practiced fifth-grade children on reading arithmetic problems and found large improvement in general reading ability to have followed upon the specific training.

Three studies, one of which by Renwick (222) has been previously mentioned, represent what may be called analytic attacks upon the nature of specific abilities. Bushnell (38) reported careful comparisons between 100 pairs of written and oral (dictated) compositions on the same subjects by the same tenth-grade children. His data revealed distinctly the differences and the relations in these two types of language use. Renwick's study (222) of children's difficulties in mensuration, while not in quantitative terms, is an exceedingly illuminating account of the way in which meaningful concepts are developed. E. W. Smith (236) presented data on the mental confusion of English teachers-in-training in solving arithmetic problems. The introspective material which she reported shows well something of the constitution of this ability.

By far the most favored method of studying the constitution of specific abilities is that of statistical correlation. To a certain extent every study which reports a coefficient of correlation between any two subjects might be listed at this point, as revealing something regarding the nature of abilities in these subjects. Fifteen investigations only will, however, be mentioned. Several of these have already appeared in other connections in the *Review*.

Engelhart (80) by the path coefficient technic attempted to determine the relations between C. A., I. Q., and comprehension in reading on the one hand and arithmetic problem-solving on the other. Measures for the last three items were secured by means of standard tests. Problem-solving scores have been correlated also by Stevens (239) against scores in a number of other school subjects for the purpose of discovering the relationships involved. Correlations were reported by Hildreth (126) between reading, arithmetic, and spelling test scores for forty-two children, the measures being obtained from the same pupils through the annual application of the Stanford Achievement Test over a period of eight years. Eurich (82,

83) studied rate and comprehension in the reading of college students. Other statistical investigations in reading were made by Deputy (71) who was interested in reading readiness; by Greene (101) who studied the relation of rate of reading to quality of comprehension as measured both immediately and after the lapse of some time; by Pyle (218), who compared reading span, as determined by individual tachistoscopic tests, with reading ability; and by Sister Mary of the Visitation (183), who made an attempt statistically to determine the relationship between various skills of a visual perceptual sort and reading and spelling ability. Rice (225) studied various factors involved in achieving success in French and Spanish, and Kaulfers (148) summarized all the correlational studies made between ability in the foreign languages and other types of measures, which included marks in other subjects, test scores, personality ratings, and the like. In addition to the study cited as having been made by Sister Mary of the Visitation (183) spelling ability was also investigated by Palmer (208) who correlated scores in spelling with intelligence test scores and scores on special tests. Talbott (255) undertook to learn something regarding the constitution of English ability by correlating marks in this subject with other high-school marks. Wittler (283) investigated the relation of rate and quality in handwriting, as well as the relation of sex and intelligence to these variables.

As a class these statistical studies are decidedly disappointing: they yield correlation coefficients but they provide no basis for the interpretation of these constants. In many of them scores on standard tests are accepted uncritically as true and complete measures of the abilities in question (239). The generally untrustworthy and inadequate nature of these basic measures controverts whatever evidence concerning the composition of abilities may eventuate from exact computations. More analytic attacks must be made if authentic and useful knowledge of the nature of ability is to be had.

MISCELLANEOUS STUDIES OF LEARNING

Logical Analysis of Learning Material

Five investigations illustrate well the possibility of securing information regarding learning from a logical analysis of the material to be learned. Grossnickle (104, 105) examined the various difficulties and errors which might arise from two different methods of teaching children to estimate the quotient figure in division. His basic material consisted, not in test data, but in the possibilities afforded by the number system itself. Horn (131) analyzed spelling words and produced evidence of possible confusion from the phonetic spelling of English words. Thus, the word "circumference" may be spelled phonetically in at least 3960 different ways through the combination of eleven different phonetic spellings for "cir," six

different spellings for "cum," and so on. Another investigation, based also on the analysis of spelling words, was made by Sartorius (230), who isolated the visual and sound elements in a list of 4000 spelling words and collected principles which have been suggested as of value in the teaching of spelling. Unlike Horn, Sartorius interpreted her data to indicate the possibility of profitable transfer: the relatively high frequencies of certain visual elements seemed to provide a hopeful basis for generalization. The types of learning in which the pupil of elementary history may expect to engage have been listed as the result of an analysis and classification of the exercises found in five elementary texts in this subject by Nudelman (199).

Conditions of Learning

The "affective tone" of words seems to have little influence upon their retention according to Chaney and Lauer (49). Twenty girls learned "pleasant" and "unpleasant" words with approximately the same degree of facility and remembered them about equally well. The type of music played during learning seems to have some effect on learners according to Jensen (137). Thus, jazz music, which in this study did not influence the speed of adding numbers in arithmetic, did lower accuracy from 93 percent to 85 percent.

Five articles reported data on the relative efficiency of the whole and the part methods of learning. A study by A. J. Davis and Meenes (68), already referred to, found that men and women were equally efficient with the part method of learning English and nonsense words, but that men were superior to women with the whole method. When the material used calls for unrelated reactions (number-letter substitution), there is some evidence that the whole method is inferior (62). The whole method has been found to be inferior to the part method and the "progressive part" method in learning poetry by Stroud and Ridgeway (246). In learning the typewriter keyboard the whole method proved to be superior, however, in an investigation by Fleming (86). Another study of the same problem by Lomax (163) was not available for review.

Distribution of practice has been the object of study in five investigations: In the case of a number-letter substitution test, distributed practice was found to be distinctly superior to massed practice by Crafts (62). Similar conclusions were reported by Lorge (164) in learning mirror-drawing. Skaggs and others (235) made three separate studies of the optimum position and frequency of interpolating recitation with reading in learning. Mixtures of reading and recitation were shown to be better than mere reading, and for any given type of material there seemed to be some optimum position and distribution of these two types of reaction. Sister Mary Immaculata (182) recommended certain principles for the direction of drill in the case of addition and subtraction in arithmetic,

favoring, among other things, the short drill period of three minutes. Coulter (61) found that the repeated reading of certain material failed to increase proportionately the amount comprehended and retained.

Conditions of Recall

Reference has already been made to the investigation by Knight and Ford (155) in which the exercise of a well-learned function was shown to be dependent upon the particular circumstances of time and position in which it was called upon to operate (multiplication combinations in arithmetic). The presence or absence of an audience was found by Burri (37) to be an influential factor both in learning and in recall. Thus, if learning took place privately, in her experiment, the presence of other persons at the time of recall was detrimental, and the nature of that audience (attentive or non-attentive) was of slight importance. Droba (78) studied the effect of order of presentation of pictures upon the recall of those pictures. The frequency of recall and the order of presentation correlated —.61; the pictures presented in the last half of the series were very much better recalled.

CHAPTER II

Methods of Teaching[1]

THE RESEARCH STUDIES dealing with methods of teaching present certain striking contrasts with the studies on learning which were reviewed in the preceding chapter. Most of the outstanding studies of learning have been carried on under rigid laboratory conditions where all essential elements are under careful control. In the very nature of the case adequate studies of methods of teaching must be carried on under conditions where the essential elements are as similar to the actual teaching situation as is possible. This means that there are many more factors to control, that there are many irrelevant elements which are extremely difficult if not impossible to eliminate, and that it is very much more difficult to be sure that the outcome is the result of the particular factor under study rather than to other concomitant factors. Consequently, one can hardly expect an equal degree of precision in the researches on methods of teaching as in the studies of learning.

Methods of teaching are never carried on in the abstract. Something must be taught and to someone. It is inevitable, therefore, that a review of the literature on methods of teaching must overlap to a considerable extent a review of the teaching of special subjects and to some extent the psychology of school subjects. However, it is the purpose of the reviewer to focus attention on the element "general method" rather than upon the particular body of subjectmatter which is being taught or the particular characteristics of the individuals being instructed. Obviously, it is impossible to make a complete separation of these concepts.

Several classifications might be followed in reviewing the studies under consideration. The writer has rather arbitrarily grouped the studies of methods into four general divisions, as follows: first, what might be called two-group comparisons where the main problem is to determine the value of one method versus another; second, those investigations which deal primarily with the evaluation of a single method and which present data relating to its effectiveness without making any direct comparison with another method; third, those studies which are essentially analytical in character, classified ordinarily as diagnostic and remedial studies; and fourth, a miscellaneous body of material which deals with rather special types of teaching. Some further clarification of this method of classifying the studies will be made in the introduction to the sections which follow.

To any critical reader of the literature on educational methods certain rather obvious questions immediately present themselves. A good report

[1] Dr. M. C. Towner of Lawrence College assisted in listing and annotating some of the materials on methods of teaching.

of research might be expected to supply the answers to such questions as the following: What was the duration of the period of trial for the method being studied? How many cases were involved? How were they selected? What were their significant characteristics? What was the nature of the controls in the experiment? Were all the essential factors controlled? Was there an adequate so-called control group against which the results may be evaluated? Was the study so set up that there is a single variable to be measured or must one rely upon statistical procedure for canceling out the variables? Was the experiment adequately supervised throughout? Was the method of measuring results adequate in terms of the purpose of the experiment? Are the results to be interpreted only within the limits of the particular situation, or was the study broad enough to permit generalization beyond the results presented? In terms of the present status of educational research one would expect a report to be clear in regard to these and other questions which seem to be pertinent to practically any investigation.

Two-Group Studies of Methods of Teaching

Approximately sixty reports were found which attempt to make a more or less direct comparison between one method of teaching and another. The term "method of teaching" in these cases is often defined in a very narrow sense and in some reports the matters actually studied might more appropriately be described as devices rather than as methods. No attempt is made here to draw a clear differentiation between the various levels of method ranging from the very specific devices and technics to the more general methods which have a very wide application. For convenient presentation the studies to be reviewed here will be grouped according to the subjects with which they were employed. In many cases the method could just as appropriately have been used with a different subject as with the one with which it was employed. Consequently, the writer would like to minimize as far as possible the particular situation in which the method was used and to emphasize those characteristics of the method as such which might be generalized over a considerable range of subject matter.

One further comment seems warranted regarding the major classification into "two-group" studies. It is entirely possible, of course, to compare two methods both of which are poor. The results of such a study may indicate that one is poorer than the other, but, obviously, the reader is not warranted in assuming that the better of the two methods is necessarily good. It may still be so poor that its use is not warranted at all. On the other hand, two very good methods may be compared in which case the poorer of the two may still be much better than other methods which might be used. A rather broad overview of the significance of the methods being compared is, obviously, important.

The two-group studies of method to be treated in this section of the chapter will be subdivided as follows: studies of (a) reading and language, (b) spelling, (c) writing, (d) social science, (e) natural science, (f) mathematics, and (g) comparisons of different materials of instruction.

(a) *Studies of Reading and Language*—Fourteen studies were found to illustrate the method of two-group comparison as related to reading and language. The nature of these studies is indicated by characteristic titles such as, "Comparative Achievement in Word Recognition under Two Methods of Teaching Beginning Reading," "Grammar by Rule or Practice," and "Extensive Individual Reading versus Class Reading."

Bergman and Vreeland (295) studied the mastery of vocabulary in the primary grades under two methods of teaching reading, namely, a visual method and a picture-story method. The characteristics of the two methods were described in detail. The visual method makes the development of ability in reading the primary end, whereas the picture-story method aims directly at growth in personality, character, and intellectual power, expecting the development of reading ability to occur as a by-product. Recognizing the difficulties of setting up a single experiment to cover all of the objectives of the methods the authors limited their investigations to one factor, namely, the development of vocabulary. The experimental set-up included subjects from three schools using the picture-story method and three similar schools using the visual method. The teachers for these experimental rooms were selected according to the principals' ratings for the preceding year. Special regulations were prepared for the classes participating, governing such matters as length of class period, outside practice in reading, preparation of supplementary instructional materials, etc. The experiment was carried on for a period of fifteen weeks, the results being measured by administering two forms of the Detroit Reading Test. Before comparing the results an elaborate analysis was made of the number of different words used in the materials of both methods and, also, of the number of these words which appeared in the various forms of the tests which were used. Tables are given showing the results in both cases. When the final data were put together the result showed that by one form of the test the picture-story method produced greater gain, whereas, by the other form of the test the visual method produced greater gain. Since an analysis of the tests showed that one of them was somewhat biased in favor of the visual method the authors came to the final conclusion that the picture-story method should be considered superior. They recognized, however, that the difference is not large and, furthermore, they gave clear recognition to the fact that their experiment had measured only one of the factors involved in the methods studied.

The limitations of the two-group method are particularly well illustrated in the preceding study. It would require a series of studies such as the one just described, each focused upon some specific objective of the method,

before any general conclusions could be drawn regarding the value of the two methods considered as a whole.

The preceding study has been described in some detail because it is typical of the better experiments classified in this chapter as two-group experiments. In this particular case the variables were handled somewhat better than in the majority of experiments to be reviewed. In contrast with the rather careful procedure of Bergman and Vreeland is a report of a comparison of the use of intensive versus extensive training in the improvement of reading ability by O'Brien (343). The data for this study were drawn from pupils in a single classroom. There were forty pupils in a class but in only eighteen cases were the data sufficiently complete to include in the report. A program of intensive reading was carried on from January to June, 1928, the results being measured by the Stanford Achievement Test, one form of which was given in January and another form in June. The elements which entered into this intensive training were described in some detail. During the following year a program of extensive reading was carried on. The nature of this program was rather loosely defined, but it centered around the field of social science. The Stanford Reading Test was also used for measuring the results of extensive reading, but instead of giving another form of the test at the beginning of the program in the autumn the results from the previous form administered in June were used. The experiment on extensive reading was carried on during the entire school year ending in May, 1929. Intelligence quotients for each of the eighteen pupils were given, the range being from 67 to 111. There were but three cases of I. Q.'s above 100. In summarizing the part of the experiment dealing with intensive reading the writer stated that the greatest gain was made not by the brighter pupils nor by the duller pupils, but rather by those classified in the middle of the group, namely, those with I. Q.'s from 79 to 98. At the end of the extensive reading program the writer summarized with a statement that the greatest gains were made by the brighter pupils. A critical reading of the report leaves much to be desired. One may well question whether the Stanford Reading Test is an adequate measuring instrument for the two types of methods which were employed. In the case of the intensive reading program the period under consideration was six months, whereas, in the case of the extensive reading program the period was one academic year. Comparisons of gains were made without due reference to this difference in the period of training. It is hardly justifiable to make any reference in this group to bright pupils since the highest I. Q. in the group was 111 and the next one below that was 103. Actually there were no bright pupils in the group, all of them being either average or dull as measured by the intelligence test. The data from the eighteen pupils show quite irregular results. For example, at the end of the period of a year's training in extensive reading two pupils made lower scores than at the beginning of the year. No consideration at all is given to fluctuations on the test nor to the low reliability of the

measure with only eighteen pupils. It is undoubtedly true that most of these limitations were unavoidable in such a limited study. The investigation was undoubtedly stimulating to the investigator, but as a piece of research it contributes nothing of value and publication of reports of this nature may lead to a degree of complacency regarding standards of educational research which may delay rather than stimulate the development of a body of scientific knowledge relating to education.

In another study of individual reading versus class reading by Field (304) a more elaborate investigation was carried on with a more serious attempt to control the various factors involved. However, the results showed little difference between extensive individual reading and class reading as measured by the tests which were given. It should be noted, however, that the evaluations were purely in terms of standard tests which did not cover all of the important objectives of the two methods. In both this and the preceding study the lack of articulation between tests and objectives is clearly illustrated.

Seibert (358) reported an interesting experiment on the relative efficiency of studying French vocabulary in associated pairs versus studying French vocabulary in context. This study was carried on with students at the college level, a total of sixty being used. Four variations in method were compared, namely, presenting vocabulary in pairs, in context, in pairs and context, and in context and pairs. The material for the study was limited to a list of twelve words and the amount of recall was tested after two, ten, and forty days. The results favored the presentation of words in pairs rather than through context. Generalization from these results is limited by the fact that only a short list of words was employed and that the novel character of the method may have produced results which would disappear if the method were used habitually. The previous habits of learning of the subjects were not described and one cannot tell from the report in which cases the methods used differed from and in which they agreed with the subject's habitual methods of learning.

Several experiments were reported dealing with various aspects of language. Bennett (294) gave informal practice to a group of seventeen children in the fifth grade trying to develop correct language usage. Incorrect sentences were written on the board and corrections were given without comment. Distinct improvement was reported as measured by the Charters test. Klopp (326) reported the superiority of formal grammar as compared with practice in eliminating errors made in standard tests. His data were drawn from 336 subjects.

Leonard (329, 330) reported an excellent control experiment, which seems to have been conducted carefully, dealing with the use of practice exercises in teaching capitalization and punctuation. Specially devised tests and practice materials were used. The method of employing practice materials was shown to have value providing the desired objective was adequately measured by the tests which were used. Thomas (367) reported

an elaborate control experiment which showed that many errors in composition can be eliminated through drill technics. The effects of specific drill on reading ability were studied by Hilliard and Barnes (315) who presented a considerable body of data on methods of drill in reading.

Braem (26) compared a phonetic method and a sight method in teaching mentally retarded pupils to read. Another reading study in the primary grades was reported by Gatto (309) who found that the workbook system of instruction was somewhat superior to the usual text method in teaching reading.

Long and Mayer (332) presented some data on the use of printing rather than cursive writing in its effects on beginning reading. The print writing seemed to help in the teaching of reading although the controls in the experiment were none too good. Stretch (245) presented a controlled experiment on the relation of problem solving in arithmetic to comprehension in reading. The nature of the training was not described very adequately, but she presented conclusive evidence of improvement.

(b) *Spelling*—In the field of spelling five studies illustrate the two-group method. Archer (7) used this method in the study of the transfer of training in spelling in an elaborate investigation carried on at the University of Iowa. He used a large number of subjects from a considerable group of school systems in which special precautions were taken to make the groups comparable. The children used were drawn from the fifth and seventh grades. The study furnishes valuable data on transfer and also illustrates very well the characteristics of a two-group experiment. Another study carried on by Gates (308) made a comparison of the study-test method with the test-study method. More than three thousand records were taken and analyzed. Comparisons were made by grades and by equivalent groups, the outcome favoring the test-study method. The author gave a good theoretical discussion of the advantages and disadvantages of the two methods which helps to explain the differences which were found. Although the test-study method was found to be superior it did not show up to as great advantage as the author apparently had expected. He pointed out the limitations of the method as used, but considered most of the limitations as removable and not serious in character. The study is worth careful reading. A third elaborate report by Zyve (376) made quite a general study of spelling methods. Several types of comparisons were made and a corresponding number of conclusions were drawn. Parts of this study again illustrate very well the two-group comparison and show the advantages and limitations of such a method of study. In a fourth study Gilbert (311) carried on a very carefully controlled experiment with thirty-two pupils in the fifth grade to determine the value of the flash-card method in teaching spelling. The experimental group showed distinct improvement at the end of a five-week period as a result of the short exposure exercises. The experiment was commendable and deserves extension to a larger group of subjects. A fifth study reported by Steinberg

(364) made a comparison of the individual method versus the class method of instruction. The study was carried on in the fifth and sixth grades, comparing two supposedly parallel groups in each grade. No decisive difference was found between the two methods. This may be due to the fact that there is no difference or it may be, and probably is, due to the fact that the pairing of the groups was not adequate. From the data presented it seems that the differences between the groups overbalance the differences between the methods. This report furnishes a good example of a study which is not yet ready for publication. It establishes no conclusions; its technics are faulty; its scope is too limited to warrant any generalization; and its evidence is internally inconsistent. The study should have been carried much further before being presented to the profession.

(c) *Writing*—An interesting investigation of remedial teaching in handwriting was reported by Scruggs (357). This was a control experiment with twenty subjects selected from two fifth-grade classes. Individualized instruction was compared with class instruction. Marked improvement was found for the individual group, the explanation being a greater consciousness of faults, errors, and progress. The report is a good example of a limited study. A second investigation of handwriting was made by Turner (261) who compared legibility and speed of manuscript and cursive handwriting. The investigator found that manuscript writing was not only superior in legibility, but, also, that it could be written more rapidly than the appropriate norms for cursive writing.

(d) *Social Science*—Comparative studies in social science incur all of the difficulties in technics experienced in other subjects with the added difficulty that the content and the objectives are somewhat broader than in the case of most other subjects. Weaver (371) reported a study of the relative value of extensive and intensive reading in United States history. The study was carried out in grade seven with control and experimental groups. Two units were taught, the methods being reversed on the second unit. The data were interpreted to show that extensive reading is as effective as intensive reading when understandings are to be measured. A somewhat better study by the same author (272) dealt with formal and informal instruction in United States history in the seventh grade. The writer tried to test the effect of formal instruction in reducing five specific types of errors in written reports. Variable results of instruction were shown for different levels of intelligence. The study was carefully done.

Crawford and Slagle (301) made a series of studies of the laboratory method in social science. Three controlled experiments were carried on, one in economics, one in history, and one in civics. The number of subjects was small, being less than thirty in each case. The laboratory method and the recitation method were rotated for seven weeks in each of the three subjects. Measurements were made by teacher-made objective tests. The evidence showed marked superiority of the laboratory method in history and civics, but only slight superiority in economics. The study is reported

too briefly for a full evaluation. Newlun (196) carried on a control experiment to show that children in the fifth grade are able to make summaries in history. He used the equivalent-group method as described by McCall and he considered this method of summarizing to be an important type of study.

(e) *Natural Science*—Seven studies of the comparative type were found which deal with the problem of method of teaching natural science. One of the best of these is a study by R. M. Parr and Spencer (346) of whether the laboratory or the recitation should have precedence in the teaching of high-school chemistry. The study was an extensive one, including 857 subjects selected from thirty-five classes taught by twenty-two teachers. Both delayed and immediate tests were used in measuring the results. The technic of the experiment is described in considerable detail and the result is stated conservatively and cautiously. The difference between the two methods was found to be small, but the technic of the study is worth careful examination. The study is set up considerably better than most of the experiments in the field of science. Noll (341, 342) reported a group of investigations to determine the optimum laboratory emphasis in college chemistry. The ratio of laboratory time to total time was varied throughout the studies. The reports are well written and contain a body of valuable data.

Some of the studies in the field of natural science fail to show any carry-over of technic from training in natural science to the making of a scientific study in education. Corbally (300) made a comparison of the traditional recitation plan with a unit plan of instruction. He used for subjects four classes in general science in high school. He admitted that the study was not very "scientifically" done. He is entirely correct. Another study by Sichler (360) may be described in much the same terms as the preceding one. The study purported to be a control experiment comparing the socialized project with the ordinary recitation method. Few data were presented and the conclusions are much broader than are warranted by the data given. A critical comparison of the evidence and the conclusions in this case will illustrate a very common defect of many of the briefer studies.

D. W. Miller (337) made a comparison of a method of topic discussion versus the method of individual projects in the study of physics. He used approximately one hundred subjects selected from six schools. These subjects were arranged into paired groups and the results determined by a test which was not described. This study again is a poor example of reporting educational research. V. C. Smith (362) reported a study of the use of reading and of laboratory work in science. This study could also be classified as rather superficial.

(f) *Mathematics*—The determination of the best method to use in subtraction has been a subject of controversy for a good many years.

J. T. Johnson (323) made a study of the efficiency of decomposition compared with that of equal addition as a technic in subtracting whole numbers. He used 693 subjects from the third grade up to the university. Each subject indicated the method which he used in subtraction. Tests were given and the results analyzed. In terms of speed and accuracy the results favored the method of equal addition. It should be noted that this was not a learning study, but that it furnished one type of data bearing upon the efficiency of the two methods. The difficulties of securing comparable groups in a study of this type are obvious.

Olander and Sharp (344) studied the relative efficiency of long division versus short division. They attempted to determine both preferences and actual efficiency of the two procedures as determined from answers to direct questions and scores on tests in grades four to twelve. The results favored the long division form. In the case of superior pupils the results were markedly in favor of long division. Repp (350) carried on a carefully controlled experiment to determine the relative value of mixed versus isolated drill organization. He studied the problem in terms of the maintenance of skill in the fifth grade. The evidence reported was distinctly in favor of mixed drill although the types of tests used to measure gain probably favored the mixed group. On the whole the study is very commendable. Morgan (339) carried on a control experiment to determine the value of specific and general drill in the fundamentals of arithmetic. The experimental group was drilled in errors discovered through use of a diagnostic test.

Two studies deal with the transfer of training in arithmetic. Overman (205) and Olander (200) carried on elaborate investigations. Overman's study is particularly commendable from the standpoint of clear-cut technic. Olander made a very comprehensive attack upon the problem and his study illustrates excellently the difficulty in maintaining adequate controls in classroom studies of method where large groups of pupils and many teachers are involved. Zyve (377) reported a two-group experiment comparing the effects of blackboard and lantern-slide presentation of arithmetic combinations when other elements in the teaching method were kept constant. The results favored the use of lantern slides. The report does not make the necessary analysis to explain the differences in results or to show whether the differences are due to essential characteristics of the two procedures or simply to unimportant details which might be modified by better controls. Shriner (233) summarized the results of a study of 1191 pupils to determine the influence of drill in reading verbal problems on ability to solve verbal problems in arithmetic. C. W. Stone (366) carried on further studies in improving ability to reason in arithmetic. He used his own diagnostic and practice tests on an experimental group and measured the results as compared with a control group in terms of his own tests. The results are rather inconclusive. At the high-school level Stokes (365) made a rather comprehensive study of the results of the

individual method as compared with the group method in ninth-grade mathematics. In the subject of geometry Pitts and R. A. Davis (348) made a comparison between what they call the synthetic method and the analytical method of teaching. Although they used a control group there were less than fifty subjects in each of the groups. The experiment was good in some respects, but rather weak in others. The conclusion of the authors was that the synthetic method was superior.

(g) *Comparisons of Materials of Instruction*—Hurd (320, 321) has studied the value of work sheets or work books as compared with the use of ordinary textbook materials. He summarized rather briefly a series of investigations in different schools in which the results are not altogether in agreement. The studies seem to be worthy of some critical attention. Kulp (328) studied the effectiveness of two types of standard practice materials for arithmetic. Although the study was a controlled experiment its value is limited to the two particular sets of practice exercises which were used. Rosse (355) studied the effects upon reasoning ability of the use of tests and practice sheets in arithmetic in the sixth grade. He carried on a controlled experiment with but eight pupils in each group. One group was taught by the textbook without any effort at diagnosis; the other by the textbook and practice materials. The results were as expected and could hardly have been otherwise. The technics of the study are open to many criticisms.

Single Group Studies of Methods of Teaching

The studies reviewed in the previous sections of this chapter were characterized by the fact that in every case there was some kind of control group which afforded a basis for evaluating the results obtained from an experimental group. Although the technics varied considerably from study to study the method of a two-group comparison ran through all of the studies. In the present section of this chapter the principal difference in the study of methods is that instead of having a separate control group with which an experimental group is compared the value of the experimental procedure is determined in general by measuring a single group at the beginning of an experiment and again at the end of the experiment. The difference in the behavior of the group is taken as an index of the effectiveness of the method used. This type of experiment is sometimes referred to as the "before and after" method. While there are many variations in its application the chief characteristic is the absence of a separate control group and the attempt to determine the effect of the change of method by the change in behavior of a single group. Some form of standardized test is ordinarily given at the beginning of the study and again at the end, although in some cases the tests used are not standardized and are made by the author of the study for the particular purpose of the experiment. Under certain conditions this method of study is entirely valid,

but in many cases there are enough factors uncontrolled to invalidate the results. On the whole this method of procedure is less valuable than the method of two-group comparison unless the study is sufficiently analytical to classify it as a definite diagnostic study where the evidence is sufficiently detailed to be illuminating in itself.

(a) *Reading and Language*—Ten studies were found in the field of reading and language which make use of the "before and after" method. As an illustration of studies of this type a typical report will be described in some detail. Lyman (165) presented one of the best studies to be described in this section of the *Review*. It illustrates both the excellent features which can come from a study where there are no control groups as well as the limitations which must necessarily affect conclusions where a control group is lacking. Professor Lyman reported a cooperative experiment in teaching junior high-school composition by thirty-one teachers working with 1039 pupils in grades six to nine inclusive drawn from twenty junior high schools and eleven elementary schools in and near Chicago. "The major purposes were (1) to determine the extent to which children of junior high-school age can be taught to discover and correct language errors in their own compositions, (2) to determine the extent to which a limited number of experiences in composition can establish work patterns by which the children plan their compositions, and (3) to determine the effect of five consecutive weeks of laboratory work upon the quality of the children's compositions" (165:748). As the teaching program is described, detailed illustrations of pupils' responses and errors were given and tabular analysis summarized the results for the different grades. The treatment is analytical and very illuminating. The conclusions which were drawn from those cooperating in the study were that pupils grew materially in language consciousness, showed satisfactory gain in avoiding minor language errors, grew accustomed to preliminary planning, and manifested some growth in the quality of their compositions. The evidence amply supports these conclusions. What the study cannot show, due to the lack of a control group, is the difference in the amount of growth which was obtained during the seven weeks' period under this method of teaching and the amount of growth which would have been obtained under the kind of teaching carried on prior to the setting up of this particular experiment. The experiment shows that the methods used produced the desired results, but the extent to which they were effective in doing this as compared with other possible methods is not indicated. This difference illustrates the outstanding contrast between the two-group experiments described in the previous section of this chapter and the single-group experiments to be reported in the present section of the chapter.

Another study of the single-group type, also in the field of language, was reported by Bennett (294). This study is extremely limited in scope as compared with the one reported in the previous paragraph. The entire study was limited to pupils in one fifth-grade class and the results are

based upon records from seventeen children. The period of experimental instruction was limited to thirty days and another ten days were devoted to testing and classifying the cases. The purpose of the study was to test one type of instruction in language. The method is described in some detail. The results of the experiment are evaluated in terms of scores on the Charter's Diagnostic Language Test, one form of which was given on June 18 and the second form on July 26. The median score on the first test was 6.5 points with a range of from 2 to 10. On the second test the median score was 16 points with a range of from 6 to 26. The average gain in score was 9 points. The writer stated that "the whole experiment was carried on as casually as possible. No charts, records, or other evidences of improvement were kept. The children were aware that they would not be marked on the results of the daily language lessons" (294:443). As a matter of fact the experiment was carried on so casually that it makes no contribution at all to an evaluation of the method which was used. The reliability of the test scores is obviously low. The fact that the experiment was carried on in a single classroom makes it impossible to determine to what extent the personality of the teacher influenced the results as compared with the contribution of the method itself, and the lack of analysis of even the limited data presented prevents the experiment from making any important contribution. It not only lacks the advantages resulting from the two-group type of experiment, but it also lacks many of the refinements in technic which are entirely possible in the single-group type of experiment.

At the college level Watson and Newcomb (370) studied the effect of a short series of brief practice periods in reading on a group of two hundred students in a class in educational psychology. Gains in speed amounting to around 15 to 20 percent were shown. No evidence is available as to how permanent were these gains nor as to whether the same technics, if applied for a longer time, would have caused additional gain. There is little reason to believe that the gains would be permanent since similar experiments indicate that approximately the same amount of gain may be obtained in almost any subject following a series of drills or practices. The experiment simply indicates that the normal rate of work can be speeded up considerably by intensive practice.

Lowry (333) reported a ten weeks' drill experiment, the purpose of which was to improve the mechanics of reading. The subjects for the experiment were the children in grades four to eight inclusive in the public school of Latrobe, Pa. No information is given as to how many children there were in these grades in this school system. Several types of tests were administered at the beginning and the end of a ten weeks' drill period and the progress made was computed in terms of the normal or standard grade progress on these various tests. The author reported gains ranging from .8 of a grade to 3 grades or six times the average gain. Without further information concerning the children in this particular school

system one is not warranted in comparing their gains with the standards on published tests, since this particular group may have been entirely different in composition from the large groups which go into the making up of standards. Substituting the group upon which tests are standardized for a control group is a convenient, but by no means defensible, practice. Furthermore, translating the gains which resulted in a short ten weeks' period of time into the terms of year gains is again open to serious question. There is ample evidence to indicate that in experiments of this type greater gains would be made during the first ten weeks than could be maintained in successive periods of ten weeks throughout an entire school year.

Camp (41) reported the results of a year's work in reading in which a new emphasis was laid upon oral reading and the results were measured at intervals of about six weeks throughout the year. The study was carried on in grades four, five, six, and seven, there being one class of pupils in each grade. A table classifying the results in oral reading as measured by the Gray Oral Reading Test showed the improvement from period to period. For the most part the results of the year's work were evaluated subjectively, there being little basis for objective evaluation of them. This study indicates very clearly the need of more scientific technics which would make possible more objective conclusions. Lacking such technics the author is forced to such a conclusion as: "The children received valuable ear-training; their vocabularies were evidently increased, as was shown in their English work; they acquired the dictionary habit, received some voice training, and improved generally in their oral reading" (41: 441). There are no data provided in the report to make possible a check on any one of these conclusions.

Garbe (307) reported a rather extensive study of correlating English and the content subjects in grade six of the elementary school. Although there was no control group the study was quite analytical in character and furnishes a very interesting body of data regarding the possibilities of this method of teaching. Further experimentation would be necessary, however, to evaluate the changes which are proposed. In the published report the author was able to present only a small portion of the total amount of data which were gathered for the unpublished report. Gumlick and Allphin (314) reported briefly the methods used and the results secured in an effort to improve interpretation of stories among third- and fourth-grade pupils. The problem is a good one and needs further study. Allen and Murphy (292) presented an interesting discussion of an experiment with an individualized group method for teaching language skills, but since they did not present a body of data showing the results of the experiment it must be classified simply as a preliminary report. Wagner (369) reported good results obtained from specific training to improve the reading ability of high-school juniors. Spink (363) described a method of teaching French in the upper grades of the elementary school and gave

the results of tests of reading ability upon pupils who have been so trained. There was no possibility of a control group for this experiment, but in view of the small number of efforts made to teach French at the elementary school level the report gives an interesting body of information as to what can be done with a group of rather select pupils in a private school.

(b) *Mathematics*—Two studies have been reported which show that lapsed arithmetical ability may be reinstated among college students with no very great amount of difficulty. Carson and Wheeler (45) showed that the poor quality of arithmetic work of college freshmen is due mostly to lack of practice and that the ability returns quickly with practice. This retention of some skill even without use is a significant fact for those persons who construct drill materials for elementary school children. Christofferson (53) presented an independent body of data leading also to the conclusion that arithmetical computation can be reinstated easily among college freshmen.

Several single-group studies have to do with problem solving in arithmetic. M. E. Brown (31) reported an experiment in using cue words to assist pupils to gain understanding of the relations within arithmetic problems. She evaluated her results mostly in terms of the immediate outcome, but there were several larger questions involved which need further study. Mitchell (338) selected five of the most difficult problems in the Orleans Arithmetic Reasoning Test, rewrote them, and provided them with analytical questions. He found that this method of treatment of the problems produced increased scores in grades seven and eight. There were 117 pupils in the classes tested. The experiment is very suggestive, but not conclusive. Osburn and Drennan (203) made a study of the effect of certain clues in problem solving among third-grade children. An initial test was given after which followed a period of six weeks' practice in which the use of certain clues was emphasized and then a second test, containing an entirely new set of clues, was given. The results showed a certain amount of transfer. Pupils of superior ability transferred more than did pupils of less ability. Neulen (340) carried on a very careful study of ability to solve 1, 2, 3, and 4 step problems. He used an interesting method of ruling out computational errors by drilling on errors found in inventory tests. The report is worth careful study. Rolker (229) reported another modification of a method to teach pupils to solve problems and measured his results by the use of standardized tests. The entire literature on methods of teaching problem solving is far from conclusive although much of it is very suggestive. The five reports mentioned here are similar to the entire body of literature in this respect.

Whistler (372) presented a brief report of an experiment in methods of teaching plane geometry. There was no controlled treatment of the results and the outcomes were stated chiefly in terms of teacher opinion.

(c) *Spelling*—Senour (232) carried on an investigation of the effectiveness of the test-teach-test method of instruction in spelling. He used 694

children from grades four, five, six, and seven of the East Chicago schools. These children were drawn from 25 different sections. The plan of the study was to give a pre-test on Monday, study on Tuesday, a re-test on Wednesday, re-study on Thursday, and a second test on Friday. He also gave a re-test at the end of one month and at the end of a three months' period. From the data secured it is evident that a pre-test and study of a list of words for a week do not produce 100 percent mastery with the type of pupils used in this investigation. However, the retention of ability acquired by the test-study-test method was very good, being 94 percent at the end of the month and 92 percent at the end of the second test given three months later. The study afforded no basis for an evaluation of the amount of gain made by the groups which were used.

An extensive investigation of learning and applying spelling rules was reported by King (153). Seven rules of spelling were taught to children in grades three to eight. After teaching, the children were tested to see whether they could remember and apply the rule to real and to nonsense words. The papers were analyzed for the purpose of comparing errors with method of teaching and with specific rules. The analyses are good and the study furnishes a very illuminating body of material. A third study of spelling was reported by Phillips (347) dealing with the teach-test-study plan in spelling. The method consisted in a study of the test results, that is, the words missed over a period of time, in which specific teaching of words missed was employed. The study showed good results although here again there is no basis for evaluating the amount of improvement which was obtained.

(d) *Miscellaneous Studies*—Shaw and Crumpton (359) carried on a study to improve the quality of handwriting in the junior high school. Previous to the experiment they had made the observation that speed of handwriting increases during the junior high-school years, but that quality failed to improve. The problem studied in the experiment was chiefly that of motivation. The various factors entering into the motivation were described in some detail. Improvement in handwriting was measured over a period of one year. While improvement was noted in the quality of handwriting as well as the rate for pupils aged eleven, twelve, thirteen, and fourteen, the greatest amount of improvement occurred with the eleven-year-old group. The authors considered the change of attitude of the children as the most potent factor in the development of increased skill. Mercer (336) studied the value of daily drill periods in handwriting in the first grade as compared with practice only on occasions when there was special motivation for it. Her conclusions at the end of the two-year period of study, in which the quality of writing was measured by a standardized writing scale, were that the incidental or specially motivated practice was more valuable than the daily drill periods.

An interesting experiment in the teaching of current events in the middle grades was reported by Kelty and Moore (324) in which the results of

using the *News Outline*, published by the American Education Press, was studied in detail. From the data presented the authors concluded that such a method is sufficient to arouse a real interest in world news with fifth- and sixth-grade pupils, that pupils of this degree of maturity can read world news intelligently, if it is presented in suitable language, and that a weekly current event paper, including enough material for a thirty minute class period, is sufficient to meet the needs of fifth- and sixth-grade children.

Two reports of an elaborate investigation in the use of typewriters in the elementary school were presented by F. N. Freeman (305) and by Wood and F. N. Freeman (375). These studies furnish the best available data on the use of typewriters with young children. Rowland (356) reported an experiment in teaching touch-typewriting in the fifth and sixth grades. Nineteen subjects were included and the study extended over fifteen weeks. The report suffers from many of the limitations of the single-group method of investigation. Wiseman (374) presented some data on the method of using term papers at the college level. While the study is open to some criticism it does call attention to the need for careful analysis of methods of using term papers.

Bell (293) measured ability to study before and after a period of instruction and training in how to study. Reliable improvement is shown as a result of the method used although this may have been due in part to the practice effect in taking the tests which were used to measure the results. C. B. Wilson (373) gathered data from over 800 pupils in grades seven to twelve to determine whether or not they had learned how to study effectively. Tests were administered before and after the teaching of how to study and improvement was measured in terms of improvement on the test. Bird (296) studied the results of a method of self-teaching and self-criticism. The technics used were not sufficiently refined to give any conclusive results. The number of factors to be controlled in such an experiment is, obviously, very large.

Studies of Diagnostic and Remedial Methods

The third sub-division of this chapter will be devoted to studies ordinarily classified as diagnostic or remedial in character. This classification does not afford a clear cut distinction in contrast with the preceding two sub-divisions. Studies of diagnostic and remedial methods may be carried on by the two-group method, using very rigid controls, or they may be carried on by the single-group method with little basis for comparison with cases other than those included in the particular study. The studies classified under this section are quite variable in character. Some of them are primarily descriptive case studies with little basis for generalization. Some of the studies are considerably more comprehensive and furnish an example of what may be expected of diagnostic and remedial procedure as a contribution to educational method. In a majority of cases the studies are treated as isolated investigations with no attempt to relate them to general

methodology. In fact the entire theory of the function of diagnostic and remedial methods seems still to be formulated. The one outstanding characteristic of all of these studies is that they are based upon the assumption that teaching is a complex process, that pupil difficulties where they are experienced are complicated in character, and that the analysis of the specific difficulties encountered may furnish a basis for specific remedial procedures which are more effective for a single pupil than any single procedure for an entire class.

(a) *Case studies*—A few of the investigations are case studies of a single subject. Such, for example, is the study of Dreis (77) who reported a case in remedial reading. The subject in this particular study was a boy thirteen years of age. He was somewhat below normal in the verbal test of intelligence, but in the performance test he exhibited advanced mechanical ability. The boy was given special instruction three periods a week for sixteen weeks, a combination of various remedial methods being used. A marked improvement in reading resulted from the special teaching, although he was not brought fully up to his normal grade level. This report is a good illustration of a brief case-study and the application of remedial methods. Such studies are primarily descriptive and do not cover a sufficient range of cases to warrant generalizations or to afford a basis for prediction. The case-study method, which on the face of it seems so easy, is in reality one of the difficult scientific technics for establishing generalized proof. Another report of a similar character was furnished by Carter (46) who also described a case in reading. In a later study (47) the same author not only gave a description of a case-study with one fifth-grade pupil, but also an account of similar work with a group of eight pupils in grades four to six. A third report of the same general type was furnished by Evans (84) who reported a remedial case in arithmetic. He gave complete diagnostic and remedial data on a child deficient in arithmetic and furnished evidences of improvement by a variety of measures. Two additional case-studies in arithmetic were reported by Trousdale (259) and by Whitson (275). These two studies are significant chiefly because of the detail in which errors are explained and methods of instruction are described.

(b) *Reading*—Reading seems to be the favorite subject for the application of diagnostic and remedial methods. G. Davis (303) reported a rather elaborate study of procedures which were found to be effective in improving pupils of poor reading ability in regular reading classes. Five hundred seventy-two pupils in grades four, five, and six were studied individually to determine their reading difficulties. The number and percentage of pupils who encountered the thirteen commonest difficulties in silent reading were given for each of the grades and, following this analysis of difficulties, an elaborate set of suggestions for remedial treatment is given. Four hundred thirteen pupils received special remedial treatment which was described. Data are given showing the amount of improvement which occurred as a result of this treatment. Although the total amount of improvement was

large, there was still a considerable number of pupils whose reading ability was not up to their mental ability by the end of the experiment. Another study by Hogoboom (128) dealt with a program of remedial reading for slow learning pupils at the junior high-school level. The report gives typical achievement records in reading and procedures which may be used to advantage with such pupils during the high-school period. Jacobson and Van Dusen (322) studied the problem of remedial instruction at the freshman high-school level. They found that 122 out of 150 entering freshmen tested below the ninth-grade standard according to the Iowa High School Reading Test. They subsequently instituted a remedial reading program which consisted of one lesson per day for eighteen weeks. Class graphs were posted and other incentives were used. The program resulted in a gain of 2.1 grades. The lack of adequate controls detracts a good deal from the impressiveness of the study. Rhoads (351) studied the effects of systematic remedial training for pupils of superior reading ability. He shows the inadequacy of "broad experiencing" as a basis of instruction. The tests used may be favorable to the "systematic" approach to reading.

McCallister has reported several diagnostic and remedial studies in reading. In one (166) of these careful case-studies of eighteen pupils in the seventh and eighth grade were selected from a larger group of 270 on the basis of thorough testing. Five types of diagnosis were undertaken, revealing three major types of deficiency and a wide variety of causes. The study was well done and deserves careful reading. In another investigation McCallister (168) dealt with reading difficulties in studying content subjects. He gave a list of fifty reading difficulties encountered by pupils in studying American history, mathematics, and general science. These difficulties were classified according to underlying causes. In a third study McCallister (334) worked out a series of excellent concrete suggestions for improving poor reading and poor study habits in grades seven and eight. The evidence of the value of the suggestions given was found in the reduction of the number of trials needed to complete certain units of work. The report furnishes good material in a difficult field. The technic of measuring the gains is open to some questions which a controlled experiment might have helped to answer. In a fourth investigation McCallister (167) studied the effectiveness of remedial instruction in reading in the junior high school. He gave records of twenty-seven retarded readers which go into considerably more detail than is the case in the majority of diagnostic studies. He also retested sixteen of his subjects after the conclusion of his remedial program. The article deals with the character of the improvement, its permanence, and the conditions which limit improvement. It is worth careful reading.

McElwee (171) conducted a study in which special instruction was given in small groups classified homogeneously as to intelligence and reading disability. Her technic included a control group and she was able to show

a considerable degree of success for the method of treatment which she employed. Wagner (369) reported a study of no great importance dealing with the effects of certain specific kinds of training. Good results were reported although adequate data were not furnished in the brief account available. Hobson and Parke (316) carried on a diagnostic study to determine whether a pupil's difficulty in reading was with comprehension alone or with both mechanics and comprehension. Data bearing upon the hypothesis set up were supplied both from group tests and from individual case studies. The number of cases used was too small to permit any adequate generalization, but the study is suggestive and the hypotheses are worth further testing.

Several studies of reading involving diagnostic or remedial technics have been carried on at the college level. F. W. Parr (345) reported a remedial project in educational psychology, showing some improvements resulting from the technics employed. Further data would throw more light upon the study. Pressey and Pressey (349) reported an experiment in training college freshmen to read in which there was evidence not only of improvement in reading ability in such situations as those used for the study, but also evidence of a spread of ability to general scholastic work. Robinson (354) carried on a study with forty-two college freshmen who ranked in the lowest tenth of their class in comprehension on the Iowa Silent Reading Examination. His data also related both to reading ability and to improvement in general scholastic work. Thompson (368) also studied the effect of remedial instruction in reading on first year college students who scored below the reading norm in the tenth grade of the high school. He found remedial instruction to be of marked value. However, so many factors were uncontrolled that the conclusions are open to some question. Zeleny (290) made a survey of the reading abilities of freshmen to determine whether they were qualified to continue work in a teachers college and to teach reading. A study was also made of the abilities of two-year graduates to determine the permanence of improvement in skill under instruction. The data from these studies were presumably intended to have some diagnostic value.

(c) *Mathematics*—Klopp, Nason, and Heilman (325) used the diagnostic and remedial method in reviewing the first three semesters of algebra with a junior-college class. Their description of the remedial program used is not sufficient and the results are not highly significant. MacRae and Uhl (180) also reported a study in algebra in which an analysis of errors was made and a remedial program was set up. An extensive diagnostic study in problem solving in arithmetic was reported by John (139) in which a detailed analysis was made of the working processes of sixty pupils in solving two-step problems. The subjects were selected from two schools in which the emphasis on problem solving had been quite different. The pupils were drawn from grades four to six, the five poorest and the five

best pupils in each class being selected for study. Forty specific types of errors were listed and described. This list furnishes a very useful guide for the diagnosis of difficulties in problem solving in the upper grades.

(d) *Spelling*—Two studies in spelling made use of diagnostic technics. Abernethy (2) reported an analysis by means of photographic records of eye movements of methods of studying spelling. Records were shown of four good and four poor spellers from grade six and also from four graduate students. The differences in methods of study were analyzed in some detail. A more elaborate study by the same technic has since been reported by Gilbert (310) in which very detailed analyses of the methods of spelling of a large group of subjects were presented. A third study of spelling was reported by McGovney (174) who made an analysis of spelling deficiencies in children of superior general ability. The report is too brief to present a large amount of data but the study could be carried farther to advantage.

(e) *Biology*—One investigation in the field of biology was reported by Blank (298) who studied the improvement in reading following a period of remedial work. Comparing the results on tests given before and after the remedial period Blank was able to show marked improvement. Lacking controls, it is impossible to evaluate the significance of the improvement which was shown.

Miscellaneous Studies of Methods

The interest in motion pictures as an aid to teaching has recently been accelerated by the development of sound motion pictures. The possibilities of visual instruction have been enlarged to such an extent that a considerable number of investigations have been carried on to determine the relative effectiveness of the various methods of presenting materials to classes. Clark (299) carried on a rather extensive study to determine the values of educational sound motion pictures as compared with two other types of teaching aids, namely, silent motion pictures and lecture demonstrations. The subjectmatter for the investigation was taken from the field of science and the study was carried on with college freshmen. A control group was used for measuring the changes in the experimental group and on the whole the technics were handled very carefully. The outcomes of the experiment were measured first by a battery of tests constructed for the purpose and related to the activities included in the film, and second, by a rather ingenious plan whereby a photograph was made of the class following a distraction stimulus in order to measure the degree of concentration of attention. The degree of concentration was determined by counting the number of students in the photograph who did not turn away from the picture or demonstrations to see what was the source of the distraction. In the conclusion the author pointed out the conditions under which sound films are more effective or less effective than silent films and how they are related to the corresponding demonstration method. The study is good both

from the standpoint of the data which are reported and from the standpoint of scientific writing. Another excellent study was furnished by F. N. Freeman and Hoefer (306) who attempted to discover the influence of motion picture films on behavior. The experiment was concerned with the use of the toothbrush. The influence of the films was studied through information tests, questionnaires on habits of care of teeth, measures of interest, and dental examination. The variety of measures used adds considerably to the value of the experiment. Holaday (317) reported a study of moving pictures in which multiple-choice tests were given at various times to parallel groups of children who had seen certain moving pictures. Two kinds of tests were used, one involving factual knowledge and the other covering the plot. A study was made of the acceptance of incorrect ideas. Complete data on the study were not available at the time the report was given. Another aspect of visual education was studied by Peterson and Thurstone (214), who were concerned with the effect of motion picture films on children's attitudes. In this particular case they measured the attitude toward Germans after the children witnessed a film which treated sympathetically the German people. As would be expected the test showed a change in attitude although no data were given as to the permanence of the change. Knowlton and Tilton (327) studied the relative values of presenting motion pictures in an auditorium and in a classroom and found, as far as the teaching of history is concerned, that superior results occurred from the showing in the classroom.

Hopkins and Dawson (319) reported an experiment in visual education in elementary college chemistry, but the controls were by no means good and the data presented were totally inadequate for the problem under consideration. Zyve (377) compared the results of using a blackboard with results from using lantern slides in the teaching of arithmetic combinations. As mentioned earlier in this chapter, she found the results from lantern slides superior. Goins (312) also studied the use of blackboards by teachers of different subjects. Meador (335) studied the extent to which pictures are an effective aid in the teaching of geography. She was concerned both with the value of the pictures and the best methods of presenting them. The data were drawn from three schools. Waymack and Hendrickson (271) made an investigation of children's reactions as a basis for teaching picture appreciation. They studied the effect of teaching appreciation in the form of ability to rate a series of pictures.

A rather useful tabulation of the various methods of teaching employed in secondary schools was made by Good (313), who classified the various types of methods and their uses. This classification of methods will undoubtedly be useful to instructors in teacher-training institutions who wish to present to their students a systematic overview of the whole field of methodology in secondary education. Several investigations deal with particular aspects of methods of teaching. For example, Blaine (297) was

interested in the status and future possibilities of the project method as used in high schools. The data for his study was secured from 150 questionnaires sent to superintendents and teachers in the state of Colorado. The data are well presented, but are obviously more satisfactory as related to the present status of the project method than to its future possibilities. The future possibilities of a method can hardly be determined by collecting the opinion of school superintendents or any other group of educational workers. A further study of individual instruction was furnished by Roberts (352), who carried on a control experiment with seventy-six pupils selected from five schools in each group. Two units of work were taught by instruction to groups and to individuals, the methods being reversed. In an earlier study (353) the same author reported the results from a control experiment in seven public schools to test the effectiveness of group or mass instruction compared with individual instruction in the subject of vocational agriculture. Lindeman (331) reported the results of a library project carried on at the kindergarten level which has some value for teachers of young children. Curtis and Darling (302) presented a good study dealing with methods of handling examination papers. Three methods were compared. In the first, pupils checked the items that were incorrect on their own papers and discussed the errors freely in class. In the second method the teacher corrected the errors and discussed them in class. In the third method the teacher wrote correct answers for all items on the papers and returned them. The report furnishes evidence as to immediate learning, retention, and the accuracy of scoring.

Two questionnaire studies deal with opposite aspects of one problem which is rather directly related to methods of teaching. Hollingsworth, Lacey, and Shannon (318) attempted to determine the school subjects which elementary-school teachers find most difficult and those which they find easiest to teach. The data were entirely teacher opinions and were gathered from something over five hundred teachers. No attempt was made in the article to relate difficulties in teaching to the types of methods which were used. The other aspect of the problem was presented by Smeltzer (361), who reported what college students consider their own difficulties. This is again a questionnaire study resulting in a table of opinions. The limited value which these two studies have might be increased by refining and extending the studies to cover the relationship between method of teaching employed and difficulty experienced either by the teachers or by students.

CHAPTER III

General Conditions Affecting Teaching and Learning

The general conditions under which instruction is carried on obviously have a great deal to do with teaching and learning. Many of these general factors are beyond the immediate control of the classroom teacher and depend to a considerable extent upon an adequate supervisory program. Studies of such general conditions will be reviewed in this chapter in the following order: (a) motivation, (b) relation of class size to instruction and learning, (c) problems of discipline and related personality traits, (d) the use of instructional materials as related to learning, (e) conditions relating to measuring the results of teaching, such as the use of examinations, marking papers, but not including a treatment of standardized tests, (f) teaching and supervising the study of pupils, and (g) miscellaneous conditions which are primarily matters of supervision.

Motivation

Seven studies have been made of students' preference for various types of activities. Those of Bowman (23, 24, 25), Crawford (391), and Garretson (92) indicated relationships with performance too low to be of significance in determining the success of individual students. Bowman did suggest, however, that his correlation of .56 between preference and performance on various types of arithmetic problems is large enough to be of significance for selecting the type of textbook problems. Three-fourths of Olander and Sharp's students preferred the long division method even in problems with one-digit divisors, and this method showed greater accuracy (344). They concluded that the long division method should be taught first, and emphasized as the method of use. Sichler (234) reported children's interests evenly divided between creative and reproductive activities, with a slight tendency for bright children to prefer creative activities.

Intrinsic motivation, that is, interest in the subject, was regarded as a determiner of superior performance by Jordan (420), Shaw and Crumpton (359), Shirley and Hevner (439), Williams (455), and Witty and Lehman (285). Symonds and Chase (444), on the other hand, found no evidence of effect of intrinsic motivation. Their subjects may simply not have been interested in the material studied. Briggs and Jordan (382) also found no improvement as a result of awareness of the personal value of the material studied. O'Shea (204) reported a study indicating that mild interest in a book is more conducive to vocabulary building than is excessive interest or none at all.

Of the various forms of extrinsic motivation, tests stand out prominently. The anticipation of a test seemed to cause improvement in the studies of

Pease (436), Thisted and Remmers (256), Turney (448), Symonds and Chase (444), Williams (455), H. B. White (453), and C. W. White (452). In this last study the test motivation took the form of exemption from semester examinations for students of superior school marks. Knowledge of success was also shown to be an effective motivating influence by F. J. Brown (30), Cocks (387), Deputy (398), Lowry (333), and Panlasigui and Knight (435). In Deputy's study this form of motivation was effective only if the attitude of the students was favorable toward the learning problem. Krueger (422), Knowlton and Tilton (327), Lester (425), and Mace (170) reported results indicating the importance of the mental set of the learning. Haefner (409) showed, however, that the will to learn was not essential. Cason and Lungren (385), Chaney and Lauer (49), and Frandsen (402) found no relation between improvement and the affective qualities of the material. Holmes (412), Jersild (419), J. N. Washburne (269), and Wright (457) made studies showing the effects of questions and assignments directing the mental activities of students.

Hollingworth and Gray (129) found no compensatory influence as a result of size in children of superior intelligence. In a comparison of the strength of various forms of incentives, competition of the sexes was found by Forlano (400) to be strongest in eleven-year-olds. Self was a stronger motive than the class or team with which an individual was identified. In a study of school marks at the college level Lehman and Stoke (424) found that a heavy schedule induced greater effort on the part of students. Turney (263) indicated that various factors of motivation were more important determiners of school marks in high school than was intelligence. Henderson (411) and B. L. Johnson (141) made studies to determine the reading selection of students. In the high school the teacher was found to be relatively important, but still not to account for a majority of the students' selections. On the basis of the prominence of the influence of friends Henderson recommended that teachers make more use of the suggestions of members of the class.

Effect of Class Size

In addition to the Jensen and Jensen summary (418) of research on the topic, seven references appeared in the years 1929 to 1932 on class size as a factor in teaching. None of these reports dealt with instructions in the elementary school; two reported investigations at the junior high-school level, E. Davis and Goldizen (396) in seventh-grade American history and D. V. Smith (442) in ninth-grade English; three, at the high-school level, Kurtz (423) in twelfth-year English, McGuire and Hudelson (428) in geometry, and P. S. Miller (430) in physics; and two, at the college level, Longstaff (426) in general psychology and O'Shaughnessy (433) in physics.

Five of the investigations employed the control-group technic of experimentation; two were statistical studies. One (430) of these latter compared the average achievement of twenty-two classes in high-school physics, as measured by a 24-item test on mechanics and a 12-item test on heat. These classes, drawn from a number of high schools, were divided into four groups of five or six each in terms of the number of students enrolled; the median numbers of pupils for these groups were 7, 14, 21, and 28, the largest enrolment being 31. The median scores increased with the size of the classes, from 19.0 to 26.5. The other statistical study by O'Shaughnessy (433) reported data on 234 lecture sections, averaging 23.7 students per section, and 90 laboratory sections, averaging 20.7 students per section. The correlation between class size and achievement in the lecture classes was +.187 as compared with +.331 for the laboratory sections. The difference in coefficients was interpreted as evidence that class size is more of a factor in achievement in laboratory work. The huge number of uncontrolled factors in these two studies makes them of little worth in evaluating the influence of class size on teaching and learning.

The other five studies, all by the control-group method, agreed in showing that achievement is not only not prevented, but may even be facilitated by increasing the number of students per teacher. Three of the studies are relatively unambitious. Kurtz (423) experimented with a class of eleven and a class of thirty-nine, equated on the basis of Terman I. Q.'s. As measured by various standard English tests the larger section proved to be fully the equal of the smaller in learning, in addition to providing more of a stimulus for the teacher. The investigation by E. Davis and Goldizen (396) made use of the Morrison technic of teaching in three units in history. The large class of seventy, which on the test for the first unit, was inferior to the two smaller classes of thirty-five each, made good its deficiency on the second unit test, and showed superiority on the third unit test. The study by McGuire and Hudelson (428) was really a report of the attempts of the first-named individual to develop an effective instructional method for the larger group. Her successes and failures were described, and evidence, in terms of scores on standard and local tests, was furnished that she finally worked out an adequate method.

The remaining two studies represent elaborate investigations which deserve careful reading. Longstaff (426) measured the effects of teaching psychology students in large classes by the lecture method and in small classes by a combination of lecture and quiz. Various types of outcome were considered, and a wide variety of comparisons is reported. The same thoroughness characterized the study by D. V. Smith (442), who herself taught the experimental and control groups. Like Longstaff, she found that she was as successful in teaching English to the large classes (about fifty pupils) as in teaching the small classes (about twenty).

The evidence, to the effect that large classes can be taught as effectively as can small classes, seems to be so overwhelming that it may appear presumptuous to raise questions concerning the usual interpretations of the findings. The earlier type of investigation, in which the same method of instruction was prescribed for both large and small classes (for example, the lecture), seems to have been discontinued as relatively futile; in such studies class size is apt to be less a factor than is some supposedly extraneous condition (such as the acoustics of the room, the speaker's voice, etc.). Instructional methods are now varied for the large and small classes (396, 426, 442), not merely because they *can* be varied, but also because they *should* be varied, if the pupil is not to suffer. But if the instructional method is varied, it is inevitable that the learner's reactions must vary, and, therefore, that the educational products must vary—if not in standard test scores, then in some way, important or unimportant, which is not now measured. Thus, recognizing that opportunities to recite (and hence to develop *some* kind of ability) must be fewer in the larger classes, some experimenters (428, 442) have largely surrendered the active teaching in the large classes to pupil leaders of pupils' groups. Not only must the learning under these circumstances be different, but it is clear also that the experimental factor has ceased to be class size and has become the comparative instructional effectiveness of teacher and pupil, or of the monitorial plan and the traditional plan of conducting classes. Perhaps it is at this point that the investigations summarized made their largest contribution—in showing that *somehow* classes numbering more pupils than are now found in typical classes can be encouraged to achieve certain types of educational outcomes and in showing what, *if* classes must be large, are the most promising instructional devices and organizations of materials.

Problems of Discipline and Related Personality Traits

The older treatment of discipline in the literature of education had its basis in authority, whereas, the more recent treatment has tended to make use of the results of scientific investigation. However, the body of truth resulting from research in this field is still very limited and the studies which are reported have a wide range in scientific value. Bittner (380) reported the results of a questionnaire circulated among teachers in one school building relating to certain problems of discipline. She then gave one case study of a disciplinary problem which is simply a description of the case and then proposed, without any objective data to support it, a plan for dealing with mentally low-grade and high-grade pupils. A study of somewhat greater value was reported by Coleman (388) in which he attempted to discover the cultural advantages of disciplinary problem pupils in high school. He presented evidence showing the cultural level of those cases

which have been disciplinary problems. As judged by twelve criteria disciplinary pupils came from the more cultured homes. The study is an interesting one and it raises some rather broad social questions.

In an attempt to measure some of the elements of personality which are basic to behavior Hendrickson and Huskey (123) reported a study of extroversion as a factor conditioning achievement in the fifth and sixth grades of the elementary school. According to the ratings on the Marston scale the investigators failed to find a marked relationship between extroversion and introversion and school achievement. Their evidence indicated that ambiverts succeed better than do the extremes of the scale. The technic of this study has some obvious applications to problems of discipline. Hollingworth and Gray (129) studied the relationship of the size of a child to juvenile achievement. They studied fifty children with intelligence quotients above 135 with respect to age, educational quotient, height, and weight. They concluded that intellectual achievement was unaffected by motivation from smallness of physique, that is, they found no compensatory influence. There are certain limitations in the technic employed for the study of such a problem, but the results are interesting as compared with some of the earlier studies which related physical size to certain problems of discipline. Keys and Whiteside (421) studied the relation of nervous stability to educational achievement. They selected children from grades six, seven, and eight in central New York state, presenting data from 182 cases. The pupils were rated by teachers by means of the Woodworth-Cady questionnaire. There was clear evidence that emotional and nervous instability, as defined by the questionnaire, was harmful to school achievement. Morton (431) reported that the correlation between teachers' grading on deportment and their grading in school subjects was suggestive of a degree of influence exerted by a pupil's conduct on his grades in school subjects. However, this point can hardly be proven by the correlation method. Another investigation, making use of the correlation method, was reported by Turney (263) who studied the relationship between intelligence, motivation, and achievement at the high-school level. He gave data on such factors as industry, perseverance, ambition, and dependability, which again has a significant bearing on problems of discipline. Williams (455) reported an experiment in self-directed education with a group of delinquent boys. The study extended over a period of five months during which time no formal instruction was given. The results showed marked improvement. There is no basis for evaluating the amount of improvement since only a single group was studied. W. L. Adams (378) studied the frequencies of reasons for failure as given by forty-one teachers. He then made a comparison of the frequencies with the professional training of the teachers. In a good many cases the reasons for failure were related to problems of discipline.

Instructional Materials as Related to Learning and Teaching

Several investigations were carried on to determine the value of one type of teaching material as compared with another type of material. In many of these cases there are several variable factors due to the fact that different kinds of teaching materials require also different methods on the part of both teacher and pupil. In these cases the difficulty of isolating a single variable for study detracts from the value of the conclusion. Dauphiny (395) made a comparison of the progress in reading of two third-grade classes, one of which used uniform materials and assignments and the other differentiated materials and assignments. Heise (410) carried on a somewhat similar study in a rural school in which pupils in grades four to eight inclusive, substituted free reading with the varied materials so involved in place of formal group instruction. L. Taylor (447) made a study of the value of student-made drawings as an aid to student achievement in laboratory work. He found that students who did not make drawings made greater achievement than those who did. Those who did not make drawings studied the ready-made illustrations which were furnished with the course. In view of the large amount of energy which the ordinary method of teaching science devotes to making drawings, the findings in this study are significant and the experiment would be worth sufficient extension to verify the results.

Vocabulary studies have become so common that it is ordinarily assumed that any new materials of instruction will be carefully controlled in this respect. Familiarity with these vocabulary investigations is expected of any competent supervisor. An illustration of the many vocabulary studies which might be listed is furnished by Dale (393, 394), who made an attempt to discover the common business terms in the English language to ascertain the frequency of their occurrence in lay reading and to find out how well children in various communities understand the most frequently used terms. He also investigated the familiarity of 167 sixth-grade pupils with forty-five common business terms. The application of studies of this type to the construction and evaluation of teaching materials is too obvious to require any comment.

A number of investigations were found which compared the value of certain workbooks with other workbooks or with textbook materials. In some cases these comparisons are of purely local interest since the materials which are compared are not widely used. In some cases the investigation is much broader and makes some genuine contribution to the problems of teaching and supervision. Gatto (309) made a rather careful comparison of the workbook system of instruction with the usual textbook method, finding the former to be superior. He (404) also set up an experiment to test the value of specially prepared practice material. Hurd (321) also dealt with the problem giving a summary of some sixteen controlled experiments which were carried on to determine the value of the workbook as an aid in instruction.

The grade placement of instructional materials is a matter of such great importance to teachers and supervisors that it is surprising to find so few fundamental investigations of this problem. Gillet (96) reported a body of data dealing with the placement of arithmetical topics which related the placement of materials to the mental abilities of children. The data reported were a part of a larger body of material gathered by a committee of seven superintendents of schools in northern Illinois. Raths (220) reported and critically examined the methods employed by this committee of seven superintendents in assigning the grade placements of topics in addition and subtraction of fractions. C. W. Washburne (267, 268) also reported data dealing with the problem of grade placement, drawing upon the material of the Committee of Seven of which he was chairman. The industry of this committee in presenting data on the important problem of grade placement is very commendable. It would seem desirable to extend their method by employing a broader base as the criterion for determining grade placement. C. R. Stone (443) also dealt with the problem of placement, reporting a study of the grading of reading selections on the basis of children's interests. It would be interesting to compare the results of a gradation of reading selections on the basis of interest as carried on by Stone and on the basis of mental ability as reported in a further study by Morphett and C. W. Washburne (193). In this latter investigation the authors studied the relation between M. A. and I. Q. on the one hand and reading success, as measured by tests, on the other. Teachers of composition will find a body of suggestive material in a report by Symonds (445) which listed a large number of topics for written compositions and furnished ratings according to the judgment of graduate students as to their frequency of occurrence and their degree of reality for high-school pupils. The motivation supplied by the topic is supposedly in direct proportion to the reality of the topic for the person who is writing. One may well raise the question as to the validity of ratings on reality made by graduate students for high-school pupils.

Problems Relating to Examinations and Students' Marks

This section will not be concerned at all with standardized tests or measurements. The studies included here are those which deal with the immediate problem of measuring results of instruction in a classroom and the assignment of grades or marks to the pupils in the class. Tests used for this purpose may be either standardized or unstandardized, most of them being of the latter type. Curtis and Darling (302) reported an interesting study on the teaching values of common practices in correcting examination papers. They made a comparison of three methods of handling papers: first, where pupils check the items that were incorrect and followed by a discussion of errors in class; second, where the teacher collected papers and corrected errors, afterwards discussing them in class before the pupils; and third, where the teacher wrote the correct answers for all the

items on the papers and returned them. The study is not only good in itself, but is suggestive of many other similar ones which could be made to advantage. Packard (434) gathered data from seventy-seven students showing, first, the type of grading plan preferred, that is, grading by letter or grading by percentage; second, the type of examination preferred. The definition of preference leaves a good deal of latitude in the replies by the subjects and the study is not of any great importance. A refinement of the technic for getting student preferences might, however, result in data of real value. C. W. White (452) studied the effect of exemption from examination on the distribution of school marks. His conclusion that exemption has not played havoc with the distribution of marks is hardly borne out by a careful analysis of the data presented. Pupils who had a mark of 85 or above were exempted from the examination. From the data given in Table I of the report the percent of grades above 85 for the two pre-examination periods were 20.5 and 23.5 respectively. For the same part of the scale during the exemption period the percent of grades was 29.8 and 32.9 respectively. The differences here seem to be considerable. Whitner (454) also dealt with the problem of the distribution of teacher's marks. His investigation, which was similar to the earlier studies made by Starch, supported Starch's general conclusion as to the wide variability in grading. New data were also presented in the report. The perennial question as to whether to mark or not was continued by Madsen (429) whose article furnishes a good example of the method of drawing conclusions from discussions rather than from facts. The article furnishes a marked contrast with the method of discovering truth by means of research.

The important question of the construction and the use of ordinary class examinations has attracted less research than would be expected. Irwin and Rankin (416) presented a stimulating article on the cooperative preparation of improved examinations. Wheatley and R. A. Davis (451) studied by means of questionnaires the teacher's use of objective examinations. Their facts were presented in eleven tables drawn from 158 teachers. Nichols (432) attempted to make an adaptation of tests in science to differing abilities. The study which was carried on in high school paid particular attention to students with low intelligence quotients. Hurd (415) also dealt with testing in the field of science in which he reported the gains in achievement in school courses measured by achievement tests. The material is good within the narrow limits of his definition of the problem.

The relation of a heavy schedule to grade of scholarship was studied by Lehman and Stoke (424). They found that students carrying a heavy load tended to make superior marks, although there is by no means any proof of a casual relationship between the two. R. A. Davis and L. W. Johnson (397) studied the influence of intelligence upon performance in new-type and old-type examinations. Their data showed that pupils perform more in accordance with their respective levels of ability when

tested by the new-type instrument. The meaning of this finding is not entirely clear. The fact that the new-type examinations and the intelligence test are cast more or less in the same form may have considerable influence on the matter. Other hypotheses could also be presented to explain the relationship. However, the problem is an excellent one and needs very much more detailed analysis than is afforded by this initial study.

The teacher's influence on class achievement was studied in great detail by H. R. Taylor (446). The author concluded that teaching ability, as measured by ratings, determines to some extent progress in reading and arithmetic. The correlations reported, however, are too low to have any predictive value. Teachers' opinions as to why pupils fail have been studied by W. L. Adams (378) who presented the frequencies for the various reasons for failure as given by forty-one teachers. He then made a comparison of these frequencies with the professional training of the teachers. The article is suggestive of a number of additional studies relating to teachers' evaluation of pupils' work. Ward (449) attempted to measure the effect of ninth-grade mathematics upon achievement in first-year algebra. However, no marked effect could be found. Such lack of generalization would become more significant if related to the various methods of teaching which were used.

Teaching Pupils How to Study

The efforts directed toward improving students' methods of study have taken four forms: (1) directing study activities; (2) teaching special study technics; (3) improving study through teaching students how to read, especially college students; and (4) measuring the effectiveness of, and students' acquaintance with, various study technics.

Directing Study Activities—Six studies have indicated benefits from questions in the making of assignments which direct the student to specific aspects of the learning problem. Briggs and Jordan (382) noted improvement only in a very narrow function especially taught. The lack of a broader effect is interpreted as due to the brevity of the experiment. Holmes (412), Jersild (419), J. N. Washburne (269), and Wright (457) found decided advantages in such direction over study following a general assignment. In Krueger's study (422) the improvement resulting from attention directed to specific items was not at the expense of other items to which attention was not directed. Four studies have shown the advantages of study guides used during the period of study. Freeble (403) found study guides profitable in modern history. Similar results were indicated by Blank (381) in science classes. Crawford and Hamren (390) and McCallister (334) reported success with various devices for guiding pupils' activities.

Teaching Special Study Technics—Newlun (196) taught children how to summarize and noted an improvement in the effectiveness of

their study. On the basis of an experimental study Barton (379) suggested that it would be profitable to give students special instruction in outlining as an aid to the study of the content subjects. Lyman (165) reported that in five weeks' instruction children were successfully taught to detect and correct their own language errors. Bell (293), Gatchel (93), Simpson (440), and C. B. Wilson (373) made studies of broader courses of training in how to study, each involving a number of technics. In Bell's study the improvement was reflected in higher scores on Part III of the Thorndike Intelligence Test. Gatchel's and Simpson's results showed improvement in ability to learn school material. Wilson found that students made little improvement in study methods from grades seven to twelve without instruction, but that special training increased their acquaintance with better methods. No evidence is given of the effect on success in school. Loofbourow (427) made a questionnaire study of the extent and nature of high-school teachers' attempts to help pupils learn to study.

Teaching How To Read—Jacobson (417) found that special reading instruction in ninth-grade general science spread to other subjects. Greater improvements were effected in poor than in good readers. Eurich (82, 399), F. W. Parr (345), Pressey and Pressey (349), and Robinson (354) made studies of improving ability at the college level. Special instruction in reading was the most important method used. Evidence is given of spread to other subjects.

Evaluation of Study Technics—Crawford (392) compared the values of reading and outlining as methods of study. No important differences were noted. Gray (408) found that children in grades four to six were not able to read effectively for the purpose of answering questions. He recommended specific training for developing this ability. Weinland (450) made a tabulation, from a questionnaire, of the prominence of various methods of study in successful college students.

Miscellaneous Studies

Discussions of supervision are much more abundant in the literature than reports of careful experiments. An example of the experimental type of study is Cocking's investigation (386) of the stenographic report as a supervisory instrument. Cocking ran a controlled experiment with ten sixth-grade geography classes, using one hundred pupils in the experimental and one hundred three pupils in the control group. He made the usual type of comparison and handled his technics carefully. The data could be analyzed further than has been done, but as the study stands it is a good example of a productive attack upon a problem in supervision. Prewit and Manuel (437) studied the differences in handwriting of supervised and unsupervised pupils. Speed and quality of handwriting were compared in schools employing supervisors in their subjects and those not employing such supervisors. While the results

favored the supervision groups the differences were small and of doubtful significance. Gillentine (407) carried on an elaborate control experiment in fifth-grade reading in which a complicated supervisory program was evaluated. The factors in the program are probably of very unequal worth and they are not evaluated. However, the study is an attempt at research in a very difficult field and deserves favorable comment. A minor study in rural supervision was furnished by Case (384) who studied the value of circulars in supervising the teaching of reading in rural schools. Selberg (438) made an analysis of student-teacher errors in a study of supervision in general science. Reports are given of the opinions of teachers and the results of interviews. Gerberich and Prall (406) studied the effects of departmental organization versus traditional organization in the intermediate grades. He evaluated the two organizations in terms of academic results and his findings have considerable bearing upon the problem of methods and supervision.

Several studies dealt with the problem of rating teachers. Cluley (57) reported some new data on the reliability of reports of teaching efficiency. He related his results primarily to supervision. Georges (405) presented a statistical method for rating instruction. His material is also of primary interest to supervisors. Coy (389) studied the various factors which influence the accomplishment quotient. Considerable data are given. Foster (401) presented data on the distribution of teacher's time among children in the nursery school and the kindergarten.

Butler (383) attempted to standardize certain practices relating to classroom management. The particular factors covered were the physical condition of the classroom, economy of time, and discipline. Data were gathered by two students from sixty teachers. The objectivity of the results was measured by correlations of responses between two sets of sixty reports made by the two observers. The reliability of the data was measured by the percent of agreement between two sets of sixty visits of the same teachers by a single observer. Hughes and Melby (413) presented an excellent, but brief report showing a cross-section of teaching in terms of classroom activities. Data were drawn from ninety-three classrooms. Humke and Fauquher (414) presented a tabulation of data showing the comments of critic teachers concerning the work of student-teachers. The value of the article will depend upon its effect in stimulating a more analytical evaluation of such comments. G. M. Wilson (456) carried on a "controlled experiment in supervision," showing an attainment of one hundred percent accuracy in the fundamentals of arithmetic. B. Smith, Swickey, and Benton (441) attempted to determine by means of a questionnaire the answer to the following questions: "How much freedom do teachers expect? Have they a professional attitude on this point? What guidance do they need?" The report is of doubtful value and is of interest chiefly in showing the range, as far as technics of research are concerned, among the various studies of supervision.

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Chapter II. Methods of Teaching

(See also Nos. 2, 7, 26, 31, 41, 45, 46, 47, 53, 77, 84, 128, 139, 153, 165, 166, 167, 168, 171, 174, 180, 196, 200, 203, 205, 214, 229, 232, 233, 245, 259, 261, 271, 272, 275, 290)

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Chapter III. General Conditions Affecting Teaching and Learning

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